RESEARCH BRANCH REPORT

1981

RAPPORT DE LA DIRECTION GÉNÉRALE DE LA RECHERCHE

Canada

Research Branch Report

1981

Rapport de la Direction générale de la recherche

RESEARCH BRANCH
DIRECTION GÉNÉRALE DE LA RECHERCHE

AGRICULTURE CANADA

Copies of this publication are available from

Research Program Service
Research Branch
Agriculture Canada
Ottawa, Ont.
K1A 0C6

On peut obtenir des exemplaires de cette
publication au

Service des programmes de recherche
Direction générale de la recherche
Agriculture Canada
Ottawa (Ont.)
K1A 0C6

©Minister of Supply and Services Canada 1982
Cat. No. A51-1/1981
ISBN 0-662-52071-8
Printed 1982

©Ministre des Approvisionnements et Services Canada, 1982
Nº de cat. A51-1/1981
ISBN 0-662-52071-8
Impression 1982

CONTENTS

Executive of the Research Branch, v *L'exécutif de la Direction générale de la recherche*, v
Administration Division, vi *Division de l'administration*, vi
Branch Financial Management, vi *Gestion financière de la Direction générale*, vi
Map of research establishments, vii *Carte des établissements de recherche*, vii
Organization of the Research Branch, viii *Organisation de la Direction générale de la recherche*, ix
Foreword, x *Avant-propos*, xi

INSTITUTES AND PROGRAM COORDINATION DIRECTORATE
DIRECTION DES INSTITUTS ET DE LA COORDINATION DU PROGRAMME
Executive, 3 *L'exécutif*, 3
Preface, 4 *Préface*, 5
- Biosystematics Research Institute, 7
- Chemistry and Biology Research Institute, 25
- Engineering and Statistical Research Institute, 39
- Food Research Institute, 47
- Land Resource Research Institute, 57
- Research Program Service, 69

ATLANTIC REGION *RÉGION DE L'ATLANTIQUE*
Executive, 77 *L'exécutif*, 77
Preface, 78 *Préface*, 79
- St. John's West, Nfld., 81
- Charlottetown, P.E.I., 87
- Kentville, N.S., 97
- Fredericton, N.B., 113

QUEBEC REGION *RÉGION DU QUÉBEC*
Executive, 127 *L'exécutif*, 127
Preface, 129 *Préface*, 128
- Lennoxville, Québec, 131
- Sainte-Foy, Québec, 141
- Saint-Jean-sur-Richelieu, Québec, 155

ONTARIO REGION *RÉGION DE L'ONTARIO*
Executive, 165 *L'exécutif*, 165
Preface, 166 *Préface*, 167
- Animal Research Centre 169
- London Research Centre 193
- Delhi, Ont., 205
- Harrow, Ont., 213
- Ottawa, Ont., 225
- Vineland Station, Ont., 241

WESTERN REGION *RÉGION DE L'OUEST*
Executive, 253 *L'exécutif*, 253
Preface, 254 *Préface*, 255
- Brandon, Man., 257
- Morden, Man., 265
- Winnipeg, Man., 273
- Melfort, Sask., 289
- Regina, Sask., 295
- Saskatoon, Sask., 303
- Swift Current, Sask., 315
- Beaverlodge, Alta., 327
- Lacombe, Alta., 335
- Lethbridge, Alta., 343
- Agassiz, B.C., 361
- Kamloops, B.C., 367
- Saanichton Research and Plant Quarantine Station, B.C., 371
- Summerland, B.C., 379
- Vancouver, B.C., 389

Program Structure, 399 *Structure du programme*, 402

Dr. E. J. LeRoux

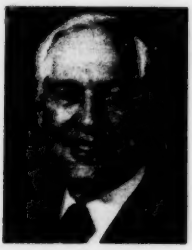
Dr. J. W. Morrison

Dr. E. E. Lister

Mr. J.-J. Jasmin

Dr. J. J. Cartier

Dr. J. E. Andrews



Dr. T. H. Anstey

EXECUTIVE OF THE RESEARCH BRANCH
L'EXÉCUTIF DE LA DIRECTION GÉNÉRALE DE LA RECHERCHE

Assistant Deputy Minister, Research
Sous-ministre adjoint, recherche
E. J. LEROUX, B.A., M.Sc., Ph.D.

Director General, Institutes and Program Coordination Directorate
Directeur général, Direction des instituts et de la coordination du programme
J. W. MORRISON, B.Sc., M.Sc., Ph.D.

Director General, Atlantic Region
Directeur général, région de l'Atlantique
E. E. LISTER, B.Sc., M.Sc., Ph.D.

Director General, Quebec Region
Directeur général, région du Québec
J.-J. JASMIN, B.Sc. (Agr.), M.Sc.

Director General, Ontario Region
Directeur général, région de l'Ontario
J. J. CARTIER, B.A., B.Sc., Ph.D.

Director General, Western Region
Directeur général, région de l'Ouest
J. E. ANDREWS, B.S.A., M.Sc., Ph.D.

Senior Adviser, International Research and Development
Conseiller principal, programmes internationaux de recherche et de développement
T. H. ANSTEY, B.S.A., M.S.A., Ph.D.

ADMINISTRATION DIVISION
DIVISION DE L'ADMINISTRATION

Director/*Directeur*	J. E. RYAN, A.C.B.A., R.I.A.
Chief, Administration Section *Chef, Section de l'administration*	D. J. DOBSON
Chief, Human Resources Section *Chef, Section des ressources humaines*	G. J. REDMOND

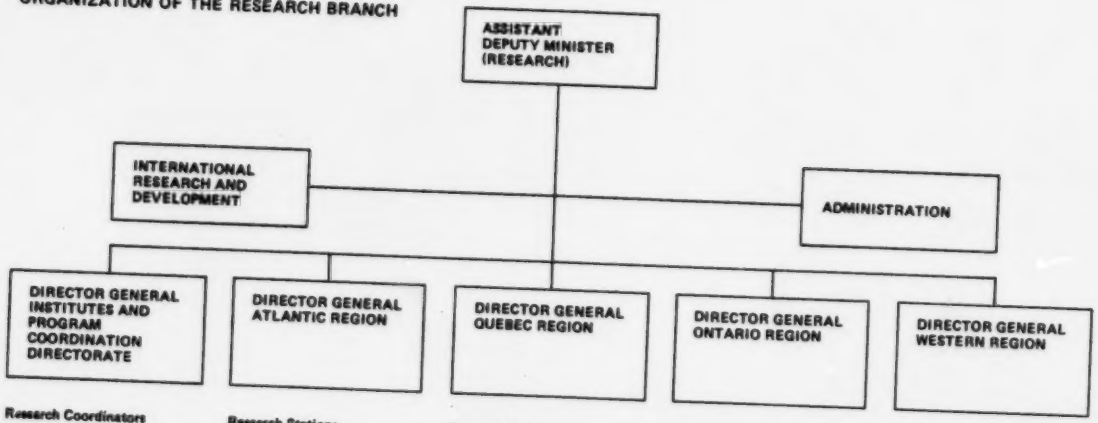
BRANCH FINANCIAL MANAGEMENT
GESTION FINANCIÈRE DE LA DIRECTION GÉNÉRALE

Manager/*Gestionnaire*	J. E. RENAUD,[1] C.D.
Financial planning/*Planification financière*	A. L. DIGNARD[1]
Financial analysis/*Analyse financière*	VACANT
Financial planning and analysis (Institutes and Ontario) *Planification et analyse financières (Instituts et Ontario)*	J. B. Moran

[1]Seconded from Finance and Administration Branch/*détaché de la Direction générale des finances et de l'administration.*

MAP OF RESEARCH ESTABLISHMENTS
AGRICULTURE CANADA
RESEARCH BRANCH
DECEMBER 1981
CARTE DES ÉTABLISSEMENTS DE RECHERCHE
AGRICULTURE CANADA
DIRECTION GÉNÉRALE DE LA RECHERCHE
DÉCEMBRE 1981
YUKON
NORTHWEST TERRITORIES
TERRITOIRES DU NORD-OUEST
BRITISH COLUMBIA
COLOMBIE-BRITANNIQUE
WESTERN REGION
RÉGION DE L'OUEST
ALBERTA
SASKATCHEWAN
MANITOBA
ONTARIO
ONTARIO REGION
RÉGION DE L'ONTARIO
QUÉBEC
QUEBEC REGION
RÉGION DU QUÉBEC
NEWFOUNDLAND
TERRE-NEUVE
ATLANTIC REGION
RÉGION DE L'ATLANTIQUE
LEGEND / LÉGENDE
REGIONAL HEADQUARTERS
ADMINISTRATION RÉGIONALE
CENTRE, INSTITUTE, OR SERVICE
CENTRE, INSTITUT OU SERVICE
EXPERIMENTAL FARM
FERME EXPÉRIMENTALE
RESEARCH STATION
STATION DE RECHERCHE
SUBSTATION
SOUS-STATION
CENTRES, INSTITUTES, AND SERVICES
CENTRES, INSTITUTS ET SERVICES

ORGANIZATION OF THE RESEARCH BRANCH



Research Coordinators

Analysts

Advisors

Research Institutes

Biosystematics
Chemistry and Biology
Engineering and Statistical
Food
Land Resource

Research Program Service

Research Stations

St. John's West, Nfld.
Colinet, Nfld.
Charlottetown, P.E.I.
Kentville, N.S.
Nappan, N.S.
Fredericton, N.B.
Benton Ridge, N.B.
Sainte-Marie, N.B.

Research Stations

Lennoxville, Que.
Sainte-Foy, Que.
La Pocatière, Que.
Normandin, Que.
Saint-Jean, Que.
Frelighsburg, Que.
L'Acadie, Que.
L'Assomption, Que.
Lavaltrie, Que.
Sainte-Clothilde, Que.

Research Centres

Animal, Ottawa, Ont.
London, Ont.

Research Stations

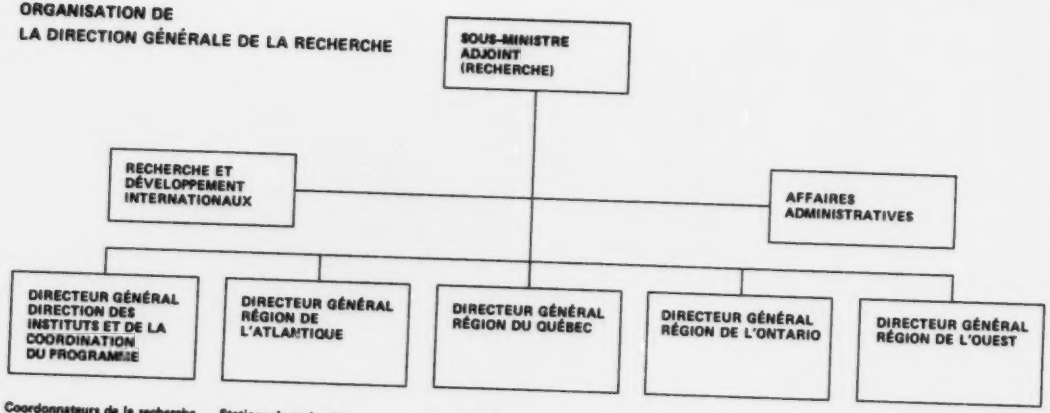
Delhi, Ont.
Harrow, Ont.
Woodslee, Ont.
Ottawa, Ont.
Kapuskasing, Ont.
Thunder Bay, Ont.
Vineland Station, Ont.
Smithfield, Ont.

Research Stations

Brandon, Man.
Morden, Man.
Portage la Prairie, Man.
Winnipeg, Man.
Melfort, Sask.
Regina, Sask.
Indian Head, Sask.
Saskatoon, Sask.
Scott, Sask.
Swift Current, Sask.
Beaverlodge, Alta.
Fort Vermilion, Alta.
Lacombe, Alta
Végreville, Alta.
Lethbridge, Alta.
Onefour (Manyberries), Alta.
Stavely, Alta.
Vauxhall, Alta.
Agassiz, B.C.
Abbotsford, B.C.
Kamloops, B.C.
Prince George, B.C.
Saanichton Research and Plant Quarantine Station, B.C.
Summerland, B.C.
Creston, B.C.
Kelowna, B.C.
Vancouver, B.C.

December 1981

ORGANISATION DE LA DIRECTION GÉNÉRALE DE LA RECHERCHE



Coordonnateurs de la recherche

Analystes

Conseillers

Instituts de recherches

Aliments
Biosystématique
Chimie et biologie
Technique et statistique
Terres

Service des programmes de recherche

Stations de recherche

Saint-Jean (T.-N.)
Colinet (T.-N.)
Charlottetown (Î.-P.-É.)
Kentville (N.-É.)
Nappan (N.-É.)
Fredericton (N.-B.)
Benton Ridge (N.-B.)
Sainte-Marie (N.-B.)

Stations de recherche

Lennoxville (Québec)
Sainte-Foy (Québec)
La Pocatière (Québec)
Normandin (Québec)
Saint-Jean (Québec)
Frelighsburg (Québec)
L'Acadie (Québec)
L'Assomption (Québec)
Levalrie (Québec)
Sainte-Clothilde (Québec)

Centres de recherche

London (Ont.)
Zootechnie (Ottawa)(Ont.)

Stations de recherche

Delhi (Ont.)
Harrow (Ont.)
Woodslee (Ont.)
Ottawa (Ont.)
Kapuskasing (Ont.)
Thunder Bay (Ont.)
Vineland Station (Ont.)
Smithfield (Ont.)

Stations de recherche

Brandon (Man.)
Morden (Man.)
Portage-la-Prairie (Man.)
Winnipeg (Man.)
Melfort (Sask.)
Regina (Sask.)
Indian Head (Sask.)
Saskatoon (Sask.)
Scott (Sask.)
Swift Current (Sask.)
Beaverlodge (Alb.)
Fort Vermilion (Alb.)
Lacombe (Alb.)
Végreville (Alb.)
Lethbridge (Alb.)
Onefour (Manyberries) (Alb.)
Stavely (Alb.)
Vauxhall (Alb.)
Agassiz (C.-B.)
Abbotsford (C.-B.)
Kamloops (C.-B.)
Prince George (C.-B.)
Station de recherche et de quarantaine des plantes de Saanichton (Sidney) (C.-B.)
Summerland (C.-B.)
Creston (C.-B.)
Kelowna (C.-B.)
Vancouver (C.-B.)

décembre 1981

FOREWORD

The Research Branch of Agriculture Canada conducts about one-half of the agricultural research and development in Canada. It also cooperates with universities and industry by supporting research that augments the Branch's goals and objectives. The budget for 1981 was $152 million, of which $7 million was spent on contracted research. In 1981 the Branch staffed 3673 person-years, of which 916 were professional positions.

Dr. A. A. Guitard left his position as Director General of the Western Region and was appointed Special Assistant to Dr. LeRoux. Dr. J. E. Andrews has become Director General of the Western Region.

This Report is divided into five sections, with each director general describing his organizational structure and highlighting achievements for the year. The research establishments then give details of their work in separate chapters, for which reprints are available.

The Branch conducts basic and applied research on soils, plants, and animals; pests including diseases and weeds; engineering and energy; and food. There is close cooperation with other branches in the Department, with other federal agencies, and with universities, provincial departments of agriculture, the agricultural industry, and farm organizations.

In Canada there is a unique system for coordinating agricultural research and services, called the Canadian Agricultural Services Coordinating Committee (CASCC). This organization reviews governmental and institutional services affecting the general welfare of Canadian agriculture. Its members include provincial deputy ministers of agriculture, deans of agricultural colleges and colleges of veterinary medicine, and representatives from the private sector. The Chairman is the Deputy Minister of Agriculture Canada. The research arm of CASCC is the Canadian Agricultural Research Council, which advises the parent committee on the state and needs of agricultural research and development. Despite resource constraints, the Research Branch has maintained a high quality of output and has contributed significantly to the departmental aims and the government's policies in support of the Canadian agricultural industry.

The Branch also strongly supports and cooperates in research at the international level. This support is partly provided through the Canadian International Development Agency and the International Development Research Centre. The Branch also has direct relations with the Organization for Economic Cooperation and Development (OECD) and the Food and Agriculture Organization (FAO). Through annual meetings with leaders of agricultural research in the USA, France, and the UK, effective exchanges are occurring and cooperation is being maintained.

E. J. LeRoux

AVANT-PROPOS

La Direction générale de la recherche d'Agriculture Canada réalise environ la moitié des travaux de recherche et de développement agricoles effectués au Canada. Elle coopère également avec les universités et l'industrie en appuyant financièrement les recherches qui viennent compléter ses buts et ses objectifs. En 1981, son budget s'élevait à 152 millions de dollars dont 7 millions pour la recherche contractuelle et son effectif était de 3673 années-personnes dont 916 employés professionnels. M. A.A. Guitard a quitté son poste de directeur général de la région de l'Ouest pour rejoindre M. LeRoux à titre d'adjoint spécial. M. J.E. Andrews est devenu directeur général de la région de l'Ouest.

Le présent rapport se divise en cinq sections, chaque directeur général décrivant l'organisation dont il est responsable et ses principales réalisations durant l'année écoulée. Chaque établissement de recherche présente ensuite ses travaux dans des chapitres dont on peut obtenir des tirés à part.

La Direction générale fait de la recherche fondamentale et appliquée sur les sols, les plantes, les animaux, les ravageurs, les pathogènes, les mauvaises herbes, le génie rural et l'exploitation de l'énergie, ainsi que l'alimentation. Elle travaille en étroite collaboration avec d'autres Directions générales du Ministère, d'autres organismes fédéraux ainsi que les universités, les ministères provinciaux de l'agriculture, l'industrie agricole et les groupements d'agriculteurs.

Le Canada s'est doté d'un mécanisme particulier de coordination de la recherche et des services agricoles. Il s'agit du Comité canadien de coordination des services agricoles (C.C.C.S.A.) dont le rôle est de superviser les services gouvernementaux et institutionnels touchant l'état général de l'agriculture canadienne. Il est composé des sous-ministres provinciaux de l'agriculture, des doyens des facultés d'agriculture et de médecine vétérinaire ainsi que des représentants du secteur privé. Son président est le sous-ministre fédéral de l'agriculture. La fonction «recherche» est confiée au Conseil de la recherche agricole du Canada qui conseille le C.C.C.-S.A. sur l'état et les besoins de la recherche et du développement agricoles. Malgré le resserrement de ses ressources, la Direction générale a réussi à conserver un rendement de haut calibre et à épauler le Ministère et le gouvernement dans la réalisation des politiques axées sur la prospérité de l'industrie agricole canadienne.

En outre, la Direction générale encourage la recherche au niveau international et y coopère énergiquement, entre autres par l'entremise de l'Agence canadienne de développement international et le Centre de recherche pour le développement international. Elle est également en contact direct avec l'Organisation de coopération et de développement économiques (O.C.D.É.) et l'Organisation des Nations-Unies pour l'alimentation et l'agriculture (*F.A.O.*). Les réunions annuelles tenues avec les chefs de file de la recherche agricole aux États-Unis, en France et au Royaume-Uni sont l'occasion d'établir des échanges fructueux et de renouer des liens de coopération.

E.J. LeRoux

INSTITUTES AND PROGRAM COORDINATION DIRECTORATE

DIRECTION DES INSTITUTS ET DE LA COORDINATION DU PROGRAMME

Dr. J. W. Morrison

Mr. P.W. Voisey

Mr. G. A. Mulligan

Dr. R.L. Halstead

Mrs. E. Larmond

EXECUTIVE OF THE INSTITUTES AND PROGRAM COORDINATION DIRECTORATE

L'EXÉCUTIF DE LA DIRECTION DES INSTITUTS ET DE LA COORDINATION DU PROGRAMME

Director General/*Directeur général*	J. W. MORRISON, B.Sc., M.Sc., Ph.D.
Acting Director General, Institutes *Directeur général intérimaire (Instituts)*	G. A. MULLIGAN, B.Sc.
Acting Director General, Institutes *Directeur général intérimaire (Instituts)*	P. W. VOISEY, F.I., Mech.E.
Acting Director General, Program Coordination *Directeur général intérimaire (Coordination du programme)*	R. L. HALSTEAD, B.S.A., Ph.D.
Program Specialist, Institutes *Spécialiste en programmes (Instituts)*	E. LARMOND, B.Sc.

Research Coordinators/*Coordonnateurs de la recherche*

Animals/*Animaux*	F. K. KRISTJANSSON, B.S.A., M.S., Ph.D.
Crops/*Cultures*	W. J. SAIDAK, B.S.A., M.S., Ph.D.
Food/*Aliments*	R. R. RIEL, B.S.A., M.Sc., Ph.D.
Production/*Production*	C. J. BISHOP, B.Sc., A.M., Ph.D., F.R.S.C., F.A.S.H.S., F.A.I.C.
Program accountability/*Imputabilité des programmes*	W. BAIER, Diplomlandwirt, Dr. Agr., M.Sc.
Protection/*Protection*	R. M. PRENTICE, B.Sc., M.Sc.
Resources/*Ressources*	R. L. HALSTEAD, B.S.A., Ph.D.

Analysts/*Analystes*

Contracts/*Contrats*	J. R. AITKEN, B.S.A., M.Sc., Ph.D.
Program/*Programmes*	J. C. ST-PIERRE, B.Sc. (Agr.), B.Sc., M.S., Ph.D.

Special Advisers/*Conseillers spéciaux*

Animals/*Animaux*	J. R. LESSARD, B.A., B.Sc., M.S., Ph.D.
Crops/*Cultures*	L. DESSUREAUX, B.A., B.Sc., M.S., Ph.D.
Crops/*Cultures*	P. P. LUKOSEVICIUS, Diplomlandwirt, M.Sc., Ph.D.
Protection/*Protection*	C. MADHOSINGH, D.I.C.T.A., B.S.A., M.S.A., Ph.D.
Resources/*Ressources*	J. L. NOWLAND, B.A., M.Sc.

PREFACE

The Institutes and Program Coordination Directorate, located in Ottawa, consists of Biosystematics Research Institute, Chemistry and Biology Research Institute, Engineering and Statistical Research Institute, Food Research Institute, Land Resource Research Institute, Research Program Service, and the Program Coordination Group. In 1981, the institutes' programs were conducted by a staff of 577 and with a budget of $18.9 million.

A cooperative mycotoxin program was initiated in Chemistry and Biology Research Institute, Biosystematics Research Institute, and Animal Research Centre in 1981 to investigate the potential hazards of these fungal metabolites in food and feed.

An improved vegetable-blancher system developed by Engineering and Statistical Research Institute and Kentville Research Station has been commercialized through an industrial development project and has received a 1981 food-processing award.

At Land Resource Research Institute, a convenient, reliable technique for measuring soil water in situ, called time domaine reflectometry (TDR), was developed and tested in cooperation with Energy, Mines, and Resources Canada.

The Food Research Institute has continued to characterize the important components of oats. New fractionation processes developed with the Ottawa Research Station have been evaluated at pilot plant level and patents have been filed.

In Research Program Service a national computerized Pesticide Research Information System (PRIS) was established in July. This system was set up in consultation with the pesticide industry, provincial and federal members of the Expert Committee on Pesticide Use in Agriculture, and concerned units of Agriculture Canada.

Program Coordination is located at Headquarters. Staff consists of coordinators, program analysts, and special advisers for the Assistant Deputy Minister of Research and the Research Branch Management Committee. Program Coordination serves also as a training ground for potential managers. Dr. W. Baier is now Program Accountability Coordinator and Dr. J. C. St-Pierre has been appointed to the Program Analyst position. Drs. F. K. Kristjansson and L. Dessureaux retired at the end of the year. The Branch was saddened by the death in January of Dr. Alan Chan, who contributed significantly to the program of the Department over the years.

In July the Director General of the Institutes and Program Coordination Directorate, Dr. J. W. Morrison, left for sabbatical leave at the University of Manitoba. The Directorate was then divided into two groups, Institutes and Program Coordination. Mr. J. J. Jasmin, Director General for the Quebec Region, Dr. C. J. Bishop, and Dr. R. L. Halstead served as Directors General of Program Coordination for the remainder of the year. Dr. Halstead has now been appointed Acting Director General on a continuing basis.

Mr. P. W. Voisey, Director of Engineering and Statistical Research Institute, and Mr. G. A. Mulligan, Director of Biosystematics Research Institute, served as Acting Directors General of Institutes during Dr. Morrison's absence.

During the year, Elizabeth Larmond was appointed Program Specialist for the Institutes.

Further information about our programs may be obtained by writing to the Research establishments concerned or by addressing inquiries to Program Coordination Directorate, Research Branch, Agriculture Canada, Sir John Carling Building, Ottawa, Ont. K1A 0C5, or Institutes Headquarters, Research Branch, Agriculture Canada, Room 2077, K. W. Neatby Building, Ottawa, Ont. K1A 0C6.

J. W. Morrison

PRÉFACE

La Direction des instituts et de la coordination du programme à Ottawa se compose de l'Institut de recherche biosystématique, de l'Institut de recherche chimique et biologique, de l'Institut de recherche technique et statistique, de l'Institut de recherche sur les aliments, de l'Institut de recherche sur les terres, du Service aux programmes de recherche et du Groupe de coordination des programmes. En 1981, l'exécution des programmes des instituts a été assurée par un personnel de 577 personnes qui disposait d'un budget total de 18,9 millions de dollars.

En 1981 toujours, un programme sur les mycotoxines a été mis sur pied conjointement par l'Institut de recherche chimique et biologique, l'Institut de recherche biosystématique et le Centre de recherche zootechnique dans le but d'évaluer les dangers qui pourraient être reliés à la présence de ces métabolites fongiques dans les aliments pour consommation humaine et animale.

Un système de blanchiment des légumes conçu par l'Institut de recherche technique et statistique, et la station de recherche de Kentville, a été mis sur le marché dans le cadre d'un projet de développement industriel. En 1981, les concepteurs se sont vus attribuer un prix de l'industrie alimentaire.

À l'Institut de recherche sur les terres, on a mis au point et éprouvé, de concert avec Énergie, Mines et Ressources Canada, une technique dite de réflectométrie (intervalle entre l'émission de signaux et leur réflexion) fiable et pratique pour mesurer la teneur en eau du sol sur place.

L'Institut de recherche sur les aliments a poursuivi ses recherches visant à caractériser les éléments importants de l'avoine. De nouveaux procédés de fractionnement élaborés en collaboration avec la station de recherche d'Ottawa ont été évalués à l'échelle pilote et des demandes de brevets ont été déposées.

Le Service aux programmes de recherche a établi en juillet 1981 un système d'information sur la recherche en défense de cultures (SIRDC). Ce système a été mis au point de concert avec les fabricants de pesticides, les membres provinciaux et fédéraux du Comité d'experts sur l'emploi des pesticides en agriculture et les services concernés d'Agriculture Canada.

Le Groupe de coordination des programmes se trouve à l'administration centrale. Le personnel se compose de coordonnateurs, d'analystes de programmes et de conseillers spéciaux au sous-ministre adjoint à la recherche et au Comité de gestion de la Direction générale de la recherche. Le Groupe sert aussi à la formation de futurs gestionnaires. W. Baier est maintenant le coordonnateur de l'imputabilité du programme et J.C. Saint-Pierre a été nommé analyste du programme. F.K. Kristjansson et L. Dessureaux ont pris leur retraite à la fin de l'année. En janvier, la Direction générale a déploré le décès d'Allan Chan, Ph.D., dont le travail a été si précieux pour le programme du Ministère pendant de nombreuses années.

En juillet, le directeur général de la Direction des instituts et de la coordination du programme, J.W. Morrison, a quitté la Direction en congé sabbatique pour se joindre à l'université du Manitoba. Après son départ, la Direction a été divisée en deux groupes—Instituts et Coordination du programme. J.J. Jasmin, directeur général de la région du Québec, C.J. Bishop et R.L. Halstead ont à tour de rôle occupé le poste de directeur général de la Coordination du programme jusqu'à la fin de l'année. R.L. Halstead a été nommé directeur général par intérim de façon permanente.

P.W. Voisey, directeur de l'Institut de recherche technique et statistique et G.A. Mulligan, directeur de l'Institut de recherche biosystématique, ont occupé le poste de directeur général par intérim des instituts durant l'absence de J.W. Morrison.

Au cours de l'année, Elizabeth Larmond a été nommée spécialiste du programme pour les instituts.

Il est possible d'obtenir de plus amples renseignements sur nos programmes en écrivant aux établissements de recherche ou en s'adressant à la Direction de la coordination du programme, Direction générale de la recherche, Agriculture Canada, immeuble Sir John Carling, Ottawa (Ont.) K1A 0C5 ou à l'Administration centrale des instituts, Direction générale de la recherche, Agriculture Canada, pièce 2077, immeuble K.W. Neatby, Ottawa (Ont.), K1A 0C6.

J.W. Morrison

Biosystematics Research Institute
Ottawa, Ontario

PROFESSIONAL STAFF

Administration

G. A. MULLIGAN, B.Sc.	Director
I. M. SMITH, B.Sc., Ph.D.	Assistant Director
E. GAVORA,[1] I.N.G., B.L.S.	Librarian, Botany
R. A. SHARRETT,[1] B.A., M.L.S.	Librarian, Entomology
J. E. H. MARTIN	Manager, National Identification Service, Zoology; Unit Curator of miscellaneous insect orders
P. M. LECLAIR	Manager, National Identification Service, Botany

Coleoptera, Lepidoptera, and Trichoptera

J. M. CAMPBELL, B.Sc., M.S., Ph.D	Head of Section; Staphylinidae (rove beetles)
S. A. ALLYSON, B.Sc., M.Sc.	Lepidopterous larvae (caterpillars)
Y. BOUSQUET, B.Sc., M.Sc.	Colydiidae, Elateridae (click beetles and wireworms, and other stored-products beetles)
D. E. BRIGHT, B.Sc., M.S., Ph.D.	Scolytidae (bark beetles), Curculionidae (weevils)
P. T. DANG,[2] B.Sc., M.S., Ph.D.	Microlepidoptera of forest importance (spruce budworm)
J. D. LAFONTAINE, B.A., Ph.D.	Noctuidae (cutworm moths); Unit Curator of Lepidoptera–Trichoptera
J. F. LANDRY, M.Sc.	Microlepidoptera of agricultural importance
L. LESAGE, B.Sc., M.S., Ph.D.	Tortricidae (leafroller moths)
F. SCHMID, Lic. ès Sc. Nat., D. ès Sc. Nat.	Trichoptera (caddisflies)

A. SMETANA, M.U.DR., Cand. Sc. Biol.	Aquatic beetles, Staphylinidae (rove beetles); Unit Curator of Coleoptera

Diptera and Hemiptera

K. G. A. HAMILTON, B.S.A., M.Sc., Ph.D.	Head of Section; Unit Curator of Hemiptera; Cicadellidae (leafhoppers), Cercopidae (spittlebugs)
L. A. KELTON, B.S.A., M.Sc., Ph.D.	Miridae (plant bugs), Anthocoridae (flower bugs)
J. F. MCALPINE, B.S.A., M.Sc., Ph.D.	Lonchaeidae (lance flies), Chamaemyiidae (silver flies)
D. R. OLIVER, B.A., M.A., Ph.D.	Chironomidae (nonbiting midges)
R. V. PETERSON, B.Sc., M.S., Ph.D.	Simuliidae (black flies), Nycteribiidae and Streblidae (bat flies)
H. J. TESKEY, B.Sc., M.S.A., Ph.D.	Tabanidae (horse flies, deer flies), dipterous larvae; Unit Curator of Diptera
J. R. VOCKEROTH, B.A., M.A., D.Phil.	Syrphidae (flower flies), Scatophagidae (dung flies)
D. M. WOOD, B.A., M.A., Ph.D.	Tachinidae (parasitic tachinid flies), Culicidae (mosquitoes)

Hymenoptera and Arachnida

E. E. LINDQUIST, B.Sc., M.Sc., Ph.D.	Head of Section; Acari (mites and ticks)
J. R. BARRON, B.Sc., M.Sc., Ph.D.	Ichneumonidae (ichneumon wasps)
V. M. BEHAN-PELLETIER, B.Sc., M.Sc., Ph.D.	Oribatei (oribatid mites)
C. D. DONDALE, B.Sc., M.Sc., Ph.D.	Araneae (spiders), Opiliones (harvestmen); Unit Curator of Arachnida
H. GOULET, B.A., B.Sc., M.Sc., Ph.D.	Symphyta (sawflies)
L. MASNER, B.Sc., M.Sc., Ph.D.	Proctotrupoidea (proctotrupid wasps), Bethyloidea (bethylid wasps), Sphecoidea (digger wasps), Evanioidea (ensign wasps); Unit Curator of Hymenoptera
W. R. M. MASON, B.Sc., Ph.D.	Braconidae (braconid wasps)
M. J. SHARKEY, B.Sc., M.Sc.	Braconidae (braconid wasps)
C. M. YOSHIMOTO,[2] B.A., M.Sc., Ph.D.	Chalcidoidea (chalcid wasps), Cynipoidea (gall wasps)

Mycology: Plant Disease and Biodegrading Fungi

R. A. SHOEMAKER, B.S.A., M.S.A., Ph.D.	Head of Section; Ascocarpic parasites of cereals
D. J. S. BARR, B.Sc., M.Sc., Ph.D.	Zoosporic parasites of vegetable crops
J. D. BISSETT, B.Sc., Ph.D.	Conidial parasites of forage crops
M. P. CORLETT, B.A., M.A., Ph.D.	Ascocarpic parasites of fruit crops
Y. DALPÉ, B.S.A., M.Sc., Ph.D.	Mycorrhizae
J. H. GINNS, B.Sc., M.Sc., Ph.D.	Curator of National Collection of Fungus Cultures; Basidiocarpic tree wood rots
S. J. HUGHES, B.Sc., M.Sc., D.Sc., F.L.S., F.R.S.C.	Conidial molds of wood and insects
G. A. NEISH, B.Sc., Ph.D.	Mycotoxin fungi
J. A. PARMELEE, B.Sc., M.A., Ph.D.	Curator of National Mycological Herbarium; Obligate parasites of plants (rusts, smuts, mildews)
S. A. REDHEAD, B.Sc., M.Sc., Ph.D.	Mushrooms

Nematology and Experimental Taxonomy

R. V. ANDERSON, B.A., M.S., Ph.D.	Head of Section; Unit Curator of Nematodes; Hoplolaimidae (spiral nematodes), Tylenchorhynchidae (stylet nematodes), Aphelenchoidea (foliar nematodes)
J. W. ARNOLD, B.A., M.Sc., Ph.D.	Insect hemoc tology (blood cells)
B. A. EBSARY, B.Sc., M.Sc., Ph.D.	Criconematidae (ring nematodes), Paratylenchidae (pin nematodes), Hemicycliophoridae (sheath nematodes)
E. S. EVELEIGH, B.Sc., M.Sc., Ph.D.	Dorylaimida (dagger nematodes), acarine systems (mites)
B. N. A. HUDSON, B.Sc., Ph.D.	Chemical taxonomy of insects—polymorphic enzymes
R. MATSUDA, B.A., Ph.D., D.Sc.	Comparative morphology

Vascular Plants

E. SMALL, B.A., B.Sc., M.Sc., Ph.D.	Head of Section; Cultivated crops, *Medicago*
S. G. AIKEN, B.Sc., M.Sc., M.S., Ph.D.	Grass flora of Canada
G. BAILLARGEON, B.S.A., M.Sc.	Weeds, Cruciferae
I. J. BASSETT, B.A.	Hay-fever plants, palynology, weeds
B. R. BAUM, M.Sc., Ph.D.	Cultivated crops, *Hordeum*
P. M. CATLING, B.Sc., Ph.D.	Sedges, aquatic plants
W. J. CODY, B.A.	Curator of Herbarium; Canadian flora, ferns
G. A. MULLIGAN, B.Sc.	Weeds, Cruciferae
S. I. WARWICK, B.Sc., Ph.D.	Weeds, genecology

Honorary Research Associates

E. C. Becker, B.Sc., M.Sc., Ph.D.	Elateridae (click beetles, wireworms)
J. A. Downes, B.Sc.	Ceratopogonidae (biting midges)
G. P. Holland, B.A., M.A., D.Sc., F.R.S.C.	Siphonaptera (fleas)
R. Macrae, B.A., M.Sc., Ph.D.	Basidiocarpic wood rots, polypores
W. C. McGuffin, B.A., M.A., Ph.D.	Geometridae (geometer moths, loopers)
O. Peck, B.Sc., M.Sc., Ph.D.	Chalcidoidea (chalcid wasps)
D. B. O. Savile, B.S.A., M.Sc., Ph.D., D.Sc., F.R.S.C.	Plant rusts
G. E. Shewell, B.Sc., M.Sc.	Lauxaniidae (lauxaniid flies), Calliphoridae (blow flies)
A. Wilkes, B.S.A., M.Sc., Ph.D.	Insect genetics

Departures

J. McNeill, B.Sc., Ph.D.	Weeds, Polygonaceae, Caryophyllaceae
W. R. Richards, B.Sc., M.Sc., Ph.D.	Aphidoidea (aphids, plant lice), Psyllidae (psyllids), Coccoidea (scale insects), Thysanoptera (thrips), Psocoptera (psocids, book lice), Collembola (springtails)

Transfer

J. R. Byers, B.S.A., M.Sc., Ph.D.	Reproductive biology and behavior of cutworm moths

[1]Seconded from Libraries Division, Finance and Administration Branch.
[2]Seconded from Environment Canada.

INTRODUCTION

The Biosystematics Research Institute maintains and develops the major National research collections of insects, arachnids, nematodes, vascular plants, and fungi; conducts research on all aspects of the biosystematics of these organisms of importance to Canadians; prepares and transfers interpretive material to workers in related fields; and provides the National Identification Service utilized by clients throughout Canada.

The program of the Institute emphasizes collection development and taxonomic study of organisms of special interest to Canadians, and production of identification guides and inventories of organisms having economic or environmental impact. These activities steadily improve the effectiveness of the National Identification Service, and the policies and procedures of this Service are reviewed regularly to ensure that the needs of clients are met efficiently.

Reprints of research publications are available from the authors. Correspondence on other matters should be addressed to the Director, Biosystematics Research Institute, Research Branch, Agriculture Canada, Ottawa, Ont. K1A 0C6.

I. M. Smith
Acting Director

COLLECTION DEVELOPMENT

The holdings of the Canadian National Collection of Insects, Arachnids, and Nematodes increased by 350 000 specimens during 1981, and the classified holdings increased by 239 000 specimens. Major contributions were made by 14 officers of the Institute, resulting from regional surveys and samplings of target groups conducted throughout temperate and northern North America. Three entomologists and one arachnologist collected specimens in the Yukon Territory, especially in glacial refugial areas. Donations to the collection from other sources totaled 49 400 specimens, and purchases of material of exceptional scientific interest amounted to 27 600 specimens. Growth of the Collection mainly involved acquisition of specimens required for current research activities of Institute scientists, but new acquisitions also increased representation of other groups of importance to Canadians. The overall scientific value of the Collection, which now comprises over 15 million specimens, was evidenced by the 170 requests from other scientists for loans totaling 49 700 specimens during 1981. The holdings of the Vascular Plant Herbarium now stand at 716 807 collections, an increase of 26 211 during 1981. Approximately 4400 collections were made during field trips by staff members in Ontario, the eastern and western provinces, the Yukon Territory, central United States, and Turkey. Some 2786 collections were donated to the herbarium, 2163 as exchange and 623 as gifts from other herbariums. The holdings of the National Mycological Herbarium stand at 235 939 specimens, an increase of 4513 accessions during 1981. A total of 1021 specimens were donated, 831 as exchange from other herbariums and 190 as gifts. Approximately 1100 collections were made by staff members during the year. The National Collection of Fungus Cultures has increased its holdings from 6558 to 7128, an increase of 570 cultures. These cultures were received for deposit from other institutions, through the Identification Service, or from isolations made by staff members. At present, 2270 cultures have been successfully lyophilized for long-term preservation.

SECTIONAL RESEARCH

Coleoptera, Lepidoptera, and Trichoptera

Coleoptera. Alleculidae: A paper was accepted for publication in which a new species of alleculid is described from California.

Buprestidae: The first draft, complete with maps, of a handbook of the Buprestidae of Canada for *The Insects and Arachnids of Canada* series has been completed.

Carabidae: A paper on the zoogeography of the *Elaphrus americanus* complex was accepted for publication and a similar paper on

the *E. finitimus* complex was submitted for publication.

Histeridae: A handbook on the hister beetles of Canada was prepared on contract for inclusion in *The Insects and Arachnids of Canada* series. The manuscript treats all species of the 33 genera known to occur in Canada.

Scarabaeidae: A handbook treating the Canadian species of scarab beetles is nearing completion. The manuscript is being prepared on contract for the Institute and is to treat all species known to occur in Canada.

Scolytidae: A paper on bark beetle larvae and several others on various aspects of scolytid taxonomy and life history were published or completed. A monograph of the genus *Pityophthorus* in North and Central America was published; it includes keys, descriptions, illustrations, and distribution maps for all known species.

Staphylinidae: Three scientists completed or published 15 papers on various rove beetle groups in 1981. These papers included a memoir-sized revision of the subfamily Xantholininae in America north of Mexico; the genus *Lordithon* (subfamily Tachyporinae); and the systematics, phylogeny, and zoogeography of the genus *Myllaena* (subfamily Aleocharinae). Shorter papers were completed on the subfamilies Aleocharinae (tribes Deinopsini and Gymnusini), Omaliinae (genera *Acidota, Arpedium, Eucnecosum,* and *Olophrum*), Oxytelinae (new genus), Staphylininae, and Xantholininae.

Tenebrionidae: The European flour beetle, *Tribolium maden* Halstead, was recorded in Canada for the first time; it was found in large numbers in boxcars that contained flour for export.

Miscellaneous: Papers were completed and submitted on the larvae of four beetle families (Cantharidae, Coccinellidae, Helodidae, Phengodidae). Substantial progress was made on an inventory of pest species of Coleoptera of agricultural importance. A major, cooperative revision of the Coleoptera of the Arctic was initiated.

Lepidoptera. Arctiidae: A paper was completed on the monotypic genus *Acsala,* in which an analysis of adult and immature stages resulted in transfer of the genus from the Lymantriidae to the Arctiidae.

Geometridae: The fourth memoir in the series *Guide to the Geometridae of Canada* on the subfamily Ennominae was published.

Noctuidae: Three papers on the genus *Euxoa* were accepted for publication. A revision of *Euxoa* in North America for the *Moths of America north of Mexico* series is nearing completion; 188 taxa are treated.

Pyralidae: Papers on the larva of the cabbage webworm and on North American species of the subfamily Pyraustinae were published. A manuscript was completed with the description of a new species of *Dioryctria* from Eastern Canada.

Tortricidae: Studies were completed in 1981 for the preparation of a paper in which the status of the eastern and western spruce budworms, *Choristoneura fumiferana* and *C. occidentalis,* is to be reviewed. This review is based on hybrid fertility, pheromone specificity results, host plant specificity, and adult morphology. Manuscripts on the genera *Eucosma, Laspeyresia,* and *Taniva* were completed in 1981.

Trichoptera. The third part of the *Trichoptera of Canada* for *The Insects and Arachnids of Canada* series was completed. It includes 10 families: Beraeidae, Brachycentridae, Calamoceratidae, Goeridae, Helicopsychidae, Hyalopsychidae, Molannidae, Odontoceridae, Psychomyiidae, and Sericostomatidae.

Diptera and Hemiptera

Diptera. The text, including introductory chapters, of Volume 2 of the *Manual of Nearctic Diptera* is nearing completion; the preparation of illustrations and captions and the scientific review of chapters covering 65 families are in progress. A catalog of Diptera types is also being prepared, with 23 families completed to date.

Anthomyiidae: Sampling for wheat bulb fly in Ontario and Quebec yielded one collection, near Levi, Que., along with many negative reports; no evidence of damage to winter wheat was noted.

Lonchaeidae: Progress was made on a revision of this family, with keys to the world genera and a revision of the species of *Neosilba* completed. As well, treatments of Nearctic species of *Chaetolonchaea* and *Protearomyia* and keys to the Nearctic species of *Dasiops, Earomyia,* and *Lonchaea* were completed.

Chironomidae: Manuscripts including definition of the 32 genera of Holarctic Diamesinae and Orthocladiinae by reference to the pupae, a review of Nearctic species of *Brillia*

and *Pegastia*, and a description of a new genus were completed.

Streblidae: A review of the bat flies of Dominica was completed, including reinterpretation of the homologies of the wing venation and terminalia.

Simuliidae: Keys to adults and pupae of Canadian *Simulium* were prepared as the initial work on a handbook to Canadian black flies, and three new species were described. A section on the morphology and biology of North American black flies with keys to genera was written for a university textbook.

Tabanidae: Treatments of the species of *Hybomitra* were prepared, including a description of a new species, as part of a handbook on Canadian horse and deer flies.

Syrphidae: Treatments of the species of six genera were prepared as part of a handbook to Canadian flower flies, and several new Nearctic species were described and new synonymies were recognized in the genera *Syrphus, Platycheirus,* and *Epistrophe*.

Culicidae: A French-language guide, including keys, to the Canadian mosquitoes was prepared.

Tachinidae: Keys were prepared for 320 Nearctic genera and subgenera, and several new combinations were recognized; keys were prepared to the 165 Canadian genera and subgenera as part of a handbook on Canadian tachinids.

Hemiptera. A manuscript on the morphology and phylogenetic development of the hemipteran head capsule was completed.

Cercopidae: The manuscript for a handbook to the Canadian spittlebugs was edited.

Cicadellidae: A guide to the leafhoppers of fruit and ornamental trees in Canada was prepared, and a revision of the New-World Macropsini and Neopsini was completed. The Nearctic species of *Gyponana* and *Evacanthus* were reviewed as part of a handbook on Canadian leafhoppers. The taxonomy and distribution of the leafhoppers of the Holarctic Region were reviewed to establish the validity of names and distribution records, resulting in numerous changes including recognition of many new synonymies and new combinations, and description of several new species and subspecies. Manuscripts, including keys to the species, of *Eratoneura* and the *Typhlocyba gillettei* complex, and an account of the host associations of grass-feeding leafhopper species were completed.

Miridae: Guides to the plant bugs associated with apple trees in Quebec and a technical bulletin on the plant bugs associated with fruit crops in Canada were completed. New species and new records of European bugs in North America were reported, and keys to seven subfamilies and 36 genera were prepared as part of a handbook to the plant bugs of Eastern Canada.

Aphididae: The manuscript for a handbook to the genera of Canadian aphids was completed.

Hymenoptera and Arachnida

Hymenoptera. The first of three important papers leading to reclassification of some major groups of Hymenoptera was published, and manuscripts for the other two were nearly completed. These contribute to a general classification basis for the introductory volume on Hymenoptera for the faunal series *The Insects and Arachnids of Canada*, on which work is also progressing. A paper describing a new mechanism for collecting flying hymenopterous insects was published.

Symphyta (sawflies): A paper on distinguishing species of *Phymatocera*, and one on recognizing species of *Gilpinia*, in North America were published. Work was furthered on a handbook on genera of sawflies of Canada, for the series *The Insects and Arachnids of Canada*.

Braconidae: An important revisionary work on *Apanteles* and related genera comprising the subfamily Microgastrinae was published, providing a reclassification of this group of parasites of lepidopterans into natural assemblages.

Ichneumonidae: A revision of North American species of *Ctenopelma*, parasites of pamphiliid sawflies, was published. A revision of the species of the genus *Pyracmon* of the Northern Hemisphere, parasites of soil-dwelling coleopteran larvae, was submitted for publication.

Calcidoidea: A revision of North American species of *Pnigalio*, ectoparasites mostly of leaf-mining lepidopterans, was submitted for publication. A guide to families and subfamilies of chalcidoid wasps was completed and submitted for the handbook series *The Insects and Arachnids of Canada*; the guide includes taxonomic keys, illustrations, diagnoses, and notes on living habits and distribution concerning 16 families and 49 subfamilies of these parasitic wasps represented in Canada.

A paper on the family Mymaridae was presented at the annual meeting of the Entomological Society of America in San Diego, CA, in 1981.

Proctotrupoidea: A revision of the platygastrid genus *Metaclisis* for North America was published. A large paper revising North American species of the scelionid genus *Gryon*, parasites of heteropterans, was submitted for publication. A paper treating species of the scelionid genus *Oethecoctonus*, parasites of tree crickets in North America, was completed.

Arachnida. Araneae (spiders): A revisionary study of North and Central American species of the wolf spider genus *Arctosa* was submitted for publication; the genus was redefined, and all species were treated. A manuscript revising the closely allied genus *Allocosa* was nearly completed. A paper revising the *nigra* group of the lycosid genus *Pardosa* for North America was published.

Acari (mites): A large manuscript describing the larval representatives of 12 known North American genera and reviewing the higher classification of the water mite superfamily Lebertioidea was completed; these mite larvae are parasites of various aquatic insect adults, especially chironomid midges. Sections of a large systematic monograph on the world genera of Tarsonemidae were reviewed internally, and other sections were redrafted and prepared for similar review; these mites feed mostly on fungi and vascular plants, though a few are parasites of insects or predators of other mites. Taxonomic and faunistic studies of oribatid mites, an important group of soil organisms, were initiated.

Mycology

Ascomycetes. A taxonomic investigation of the Canadian species of *Mycosphaerella* parasitizing certain economically important groups of plants (grasses, legumes, and crucifers) progressed, as well as a study on a previously undescribed hypodermataceous fungus parasitizing the needles of white pine. Work was concluded on some *Lophodermium* parasites of Ericaceae.

Coelomycetes. A manuscript was prepared describing a disease on *Cissus rhombifolia* Baker (grape ivy) in Ontario greenhouses caused by *Pestalotiopsis menezesiana.* Reassessment of other species of *Pestalotiopsis* occurring on Vitaceae, resulting in some new combinations, and a key to facilitiate identification of *Pestalotiopsis* and related fungi on Vitaceae were included. Manuscripts on commonly occurring septorioid fungi parasitic on Gramineae were submitted.

Hyphomycetes. Descriptions of two common species of *Stemphylium* occurring on legumes, including a key to all of the known leguminicolous species of *Stemphylium*, were completed. Taxonomic studies of the Canadian species of *Helminthosporium* and *Bactrodesmium* are nearing completion.

Mushrooms. The causal agent of a low-temperature crown rot of western forage crops was described as a new mushroom species of *Coprinus*; a description of the new species was necessary to classify this pathogen. The new mushroom genus *Resinomycena* was described. A new species of *Marasmius* from wetlands was published, along with descriptions of other wetland agarics in Canada; parasitism of peat moss by both cup fungi and mushrooms was documented.

Mycorrhizae. A new research area concerns mycorrhizal mushrooms, the ectendomycorrhizae, which are mainly ascomycetes associated with Ericaceae, as well as vascular–arbuscular endomycorrhizae (*Gigaspora* and *Glomus* species) found on roots of many important economic crops. The first objective is to develop a representative collection for reference in identification of these organisms. Different techniques of infecting roots and of preparing axenic cultures are being developed to improve growth of mycorrhizal plants.

Mycotoxin fungi. Collaborative work with scientists at the Animal Research Centre and the Chemistry and Biology and the Food Research institutes has been concerned primarily with studies on vomitoxin (deoxynivalenol) and zearalenone production by *Fusarium graminearum* with emphasis on the development of methods for producing large amounts of purified vomitoxin for use in animal feeding trials. The toxigenic potential of strains of *F. acuminatum, F. equiseti, F. poae,* and *F. sporotrichioides* was also investigated. Some of this work was done in collaboration with scientists at the University of Saskatchewan and the Saskatoon Research Station. *F. poae* and *F. sporotrichioides*, two species common on Gramineae, were described.

Rust fungi. Three rusts parasitizing the Campanulaceae (bluebell family), including a species which alternates to Pinaceae (pine family: *Pinus banksiana*) and two species attacking Araliaceae (ginseng family), were described. Parasitic fungi of 113 species were reported for Riding Mountain National Park, Man.; 53 taxa were reported from this region for the first time.

Wood rots. Studies on wood decay fungi in the genera *Hericium* and *Steccherinum* centered on description of features produced in laboratory culture and cirumscription of the species.

Work on a reference book on plant disease fungi in Canada continues. It is intended to supplement the 1967 book *An Annotated Index of Plant Diseases in Canada* and will be an up-to-date reference for plant pathologists, ecologists, and other biologists.

Zoosporic fungi. Ultrastructural examination of selected species has shown fundamental differences in their flagellar apparati and microtubular rootlet systems. On this basis the natural relationships of Oomycetes (including the phytopathogenic genera *Phythium* and *Phytophthora*) with heterokont algae and of Plasmodiophoromycetes with Protozoa were elucidated. No relationship of Chytridiomycetes with eukaryotic organisms that have modern-day representatives was evidenced. These data, and a comprehensive review of the literature on fungal thalli, life cycles, and chemotaxonomy, were included in a chapter on the systematics of the zoosporic fungi submitted for a book entitled *Zoosporic Plant Pathogens*.

Nematology and experimental taxonomy

Nematology. Descriptions of several new Canadian species of plant-parasitic nematodes, including a new genus and three species (Tylenchorhynchidae) recorded from the Canadian Arctic for the first time, were published. Species groups of ring, spiral, stunt, wild rice root, and pin nematodes were studied, along with a rare, aquatic species of *Eutylenchus*. Keys were prepared to facilitate identification of 111 species of these groups. An initial study of the predaceous nematodes of the genus *Paractinolaimus* in Canada resulted in the identification and publication of two undescribed species.

Cooperative work with the Vineland Research Station continued, with emphasis on nematode virus vectors and root-lesion nematode complexes. Of significance, a new species of pin nematode (*Longidorus*) was experimentally proven to be the natural vector of peach rosette mosaic virus in Ontario. Work is in progress to resolve difficult species complexes of the virus-transmitting dagger nematodes (*Xiphinema*). Research to establish reliable diagnostic characters of root-lesion nematodes, aided by scanning microscopy, was expanded.

Biosystematics of cutworms. Published data on field trials using traps baited with females of one species demonstrated that males of the North American species of *Xestia adela* and *X. dolosa* are significantly attracted to conspecific females, and that reproductive isolation has resulted from differences in sex pheromones. Experiments confirmed that laboratory populations of these species do not hybridize, and that their larvae have different rates of development and show allozyme differences. A manuscript was completed establishing that characteristics of the hemocyte complex reflect the level of specialization of noctuid cutworms and can be used to elucidate the phylogeny of species within taxonomic groups. Special staining procedures revealed unequivocal examples of mitosis in spherule cells of Lepidoptera, indicating that these cells have greater potential to divide than was reported previously.

Evolutionary concepts. Theoretical studies of the possible influence of environmentally induced hormonal gene regulation on the evolution of animals were continued.

Vascular plants

Alfalfa. Numerical analysis resulted in a key to the principal subspecies of alfalfa. An analysis of infection specificity of the main subspecies of alfalfa by a seed chalcid was completed, showing that resistance to attack was correlated with the extent of coiling of the fruits. Differences between subspecies of alfalfa in ability to accumulate agronomically significant chemicals were documented, permitting new insight into the study of nutrient content and the value of tissue analysis as a means of assessing nutrient deficiency. Studies revealed that flavonoid characters of species of *Medicago* are of taxonomic importance, and that the taxonomic values of different sets of characters (fruiting, floral, chemical, pollen, vegetative) were similar,

except for pollen characters that were apparently less reliable.

Barleys. The first report of a worldwide barley registry that includes pedigrees, coefficients of parentage, synonyms, and other pertinent data was published and sent to barley breeders worldwide for feedback of information.

Fescues. An assessment of taxonomic problems in the genus *Festuca* in Canada was initiated, and a grass garden was started to determine how *Festuca* species from various localities in Canada grow under uniform conditions in Ottawa.

Trefoils. Palynological investigations of trefoil (*Lotus*) and related genera showed a clear separation of the North American and Old-World taxa. The two groups could be distinguished on the basis of both ultrastructural and light-microscopic details.

Wheat group. Analyses based on ultrastructure wax morphology as revealed by electron microscopy and chemistry were carried out, providing assessments of generic relationships and of the relative importance of various characters. A new phylogenetic classification of Triticeae was completed, and an invited lecture on this subject was presented, which will be published in a book on cladistic methodology.

Inventory of cultivated crop plants of Canada. Literature collection continued toward the compilation of treatments of all plants known to be cultivated outdoors for crop purposes in Canada.

Biology of weeds series. Accounts of the poisonous water-hemlocks and poisonous cherries that have caused heavy livestock losses in Canada were completed. A treatment of ragweed (*Ambrosia*), including cytological investigations, was completed, along with an account of yarrow (the *Achillea millefolium* L. complex), one of the commonest weeds in Canada.

Herbicide-resistant weeds. Studies of differential growth and competitive relations of triazine-resistant and susceptible weed strains of redroot and green pigweed were published, indicating that resistant strains of both species are less competitive than susceptible strains.

Genecology of new problem weeds in Ontario. Distribution maps of new problem weed species in Canada were prepared, and standard garden trials were initiated to compare populations from different areas. These included silky bent grass, Johnson grass, velvetleaf, wild proso millet, hairy galinsoga, flower-of-an-hour, giant foxtail, and jimsonweed.

Plantain. A paper was submitted on genecology of populations of *Plantago major* L. comparing growth, flowering, and population variability in two subspecies, as well as populations from different habitats.

Marsh hedge-nettle. A paper was completed discussing *Stachys palustris* L., an introduced weed of fields in the Maritimes. Further studies are continuing on the cytotaxonomy of the entire genus in North America north of Mexico.

Solanaceous weeds. Weedy and poisonous Canadian taxa of *Solanum, Physalis, Datura,* and *Hyoscyamus* were examined. New seed characters for diagnosing taxa were prepared, as well as distribution maps and photomicrographs of seed characteristics.

Inventory of Canadian weeds. Preparation of an inventory of all weeds and other noxious or potentially noxious plants found in Canada was essentially completed. For each of the approximately 1500 species included, information will be published on the correct scientific name, widely used synonyms, English and French names, geographic distribution, and habitat.

Aquatic plants. An inventory of Canadian aquatics was begun. An article was prepared concerning the status and identification of two very similar species, *Hydrocharis morsus-ranae* L. and *Limnobium spongia* (Bosc.) Steud.

Sedges. The discovery of three sedges new to the Canadian flora prompted the preparation of a note outlining their identification, ecology, and phytogeography.

Orchids. Three articles were prepared on *Spiranthes* orchids, indicating the relationship between floral structure and pollination; describing breeding systems in the group, with emphasis on agamospermy; and reporting on the identity, ecology, and distribution of *Spiranthes* in Michigan. Statistical and ecological analysis resulted in description of a new orchid variety from southern Nova

Scotia. A symposium paper was completed on the terrestrial orchids of Canada.

Floristic studies. A phytogeographic study of some species of restricted distribution in southern Ontario has been accepted for publication. Work is proceeding on a manual of the vascular plants of Riding Mountain National Park. Two weeks were spent in the mountains of the eastern Yukon Territory adjacent to the Canol Road, gathering specimens to be used in the preparation of a study on the flora of the Yukon. Floristic and vegetation studies of Long Point in Norfolk County, Ont., resulted in two publications. A review of the occurrence of salt-tolerant plants in the eastern Great Lakes region was completed.

TECHNOLOGY TRANSFER

Highlights of technology transfer during 1981 were the preparation and publication of various identification aids and faunistic and floristic treatments.

The Insects and Arachnids of Canada. This series is designed to treat the Canadian fauna of these organisms in a way that will allow the nonspecialist to identify the various taxa. During 1981, the manuscript on larvae of the genera of chironomid midges of Canada was completed, providing the first comprehensive treatment of these organisms, which are important in ecological and environmental studies of freshwater habitats.

Manual of Nearctic Diptera. Volume 1 was published early in the year. This excellent work represents the most complete and thorough treatment of the taxonomy and biology of this order of insects ever published. It has received enthusiastic acclaim from the scientific community.

Grass genera of Western Canadian Cattle Rangelands. The manuscript for this publication was prepared and is now being revised. It is intended to assist students, technicians, research scientists, and agricultural workers in identifying the 64 genera of grasses found in cattle rangelands of Western Canada. A key to these genera is given, utilizing both vegetative and reproductive characters.

Ferns and Fern Allies of Canada. A manuscript on the fern and fern allies of Canada has been substantially completed. Several species are weedy in nature, at least one is reputed to be carcinogenic, one is a delicacy that is harvested and sold commercially, and some are used for decorative purposes, both living and dried.

Ontario Orchids. A manual of the orchid flora of Ontario was completed. This work treats 68 taxa, including 59 species. Identification keys are provided, along with illustrations and distribution maps for each species. The text includes information on ecology, pollination, biology, taxonomy, and flowering time. The work is of general interest to botanists, naturalists, and environmental consultants.

Plants Poisonous to Livestock in Canada. Considerable progress was made on a manuscript treating plants that are poisonous to livestock in Canada.

Seed Jewelry. An article was prepared, providing illustrations and descriptions of seeds, nuts, and fruits most commonly used in jewelry. The identification of this kind of material is important because some seeds are very poisonous.

Fungi Canadenses. In 1981, 20 contributions to *Fungi Canadenses* were published, bringing the total in this series to 210. Taxa illustrated and described include new records of Canadian fungi, one new species, and one new variety. Species of parasitic and biodegrading fungi from the following genera were described: *Calyptella, Capnobotrys, Lophodermi, Phragmocephala, Polymyxa, Puccinia, Uromyces, Ustilago,* and *Venturia.*

NATIONAL IDENTIFICATION SERVICE

A total of 119 830 specimens of insects, arachnids, and nematodes were identified during 1981, an increase of 28% over the previous year. Environment Canada (34%), Agriculture Canada (16%), and American and Canadian Universities (13 and 8%, respectively) were the greatest users. Some 9640 specimens were received from the general public for identification or general information or as a control measure. Opportunity was provided on three occasions in the past year to assist police investigations of sudden human fatalities, using blow fly larvae as forensic indicators. Blow flies lay eggs on corpses shortly after death, and the rate of development of the eggs and subsequent three

Botanical identifications for 1981

	Arthropods and nematodes, number of specimens	Vascular plant collections[1]	Fungus collections[1]	Fungus cultures[2]	Total
Canada					
Agriculture Canada	19 277	213	44	314	19 848
Environment Canada	41 623	488	114	112	41 850
Other federal departments	1 616	481	619	197	2 913
Provincial departments	3 303	360	85	75	3 823
Industry	75	—	4	2	81
Universities	9 976	888	144	104	11 112
General public	9 640	669	640	19	10 968
USA					
Government departments	7 008	114	35	10	7 167
Universities	15 601	250	150	15	16 016
General public	882	—	—	—	882
Other countries	11 316	59	158	22	11 555
Total	119 830	3 522	1 993	870	126 215

[1] The term collection refers to all of the plants of one species that were collected at a certain location at one time and may in fact comprise from one to more than a thousand individuals.

[2] The term culture denotes a living fungus population aseptically cultivated on various substrata under different conditions, usually to obtain identifiable structures of different states in the life cycle.

larval instars depends on temperature. Given the air temperature during the days preceding discovery of the corpse, police personnel could estimate the minimum elapsed time between death and discovery by collecting and preserving the larvae to determine the growth stage of the oldest larvae.

This year 3522 collections of vascular plants were identified. Universities were again the major users of this service (25.2%). An increased number of inquiries was received directly from the general public and through Public Services Section, Communications Branch, Agriculture Canada. Assistance was provided to the Poison Control Centre for 27 cases of suspected poisonings from vascular plants.

A total of 2863 collections and cultures of fungi were identified during 1981. Principal users of the service were Agriculture Canada (12.5%) and other federal departments (28.5%), followed by the general public (23.0%). Assistance was provided to the Poison Control Centre for 62 cases of suspected poisonings from mushrooms. The accompanying table shows the number of specimens identified and their sources.

PUBLICATIONS

Research

Aiken, S. G. 1981. A conspectus of *Myriophyllum* (Haloragaceae) in North America. Brittonia 33(1):57-69.

Aiken, S. G. 1981. An experiment relating vegetative morphology of *Myriophyllum alterniflorum* DC. (Haloragaceae) to growth substrate. Aquat. Bot. 10:383-388.

Allyson, S. A. 1981. Description of the last instar larva of the cabbage webworm, *Hellula rogatlis* (Lepidoptera: Pyralidae), with a key to larvae of North American species of *Hellula* Guenée. Can. Entomol. 113:361-364.

Allyson, S. A. 1981. Last instar larvae of Pyraustini of America north of Mexico (Lepidoptera: Pyralidae). Can. Entomol. 113:463-518.

Barr, D. J. S. 1980. An outline for the reclassification of the Chytridiales, and for a new order, the Spizellomycetales. Can. J. Bot. 58(22):2380-2394.

Barr, D. J. S. 1981. Ultrastructure of the *Gaertneriomyces* zoospore (Spizellomycetales, Chytridiomycetes). Can. J. Bot. 59(1):83-90.

Barr, D. J. S.; Allan, P. M. E. 1981. Ultrastructure of *Kochiomyces* and *Triparticalcar* zoospores (Spizellomycetales, Chytridiomycetes). Can. J. Bot. 59(5):649-661.

Barron, J. R. 1981. The nearctic species of *Ctenopelma* (Hymenoptera, Ichneumonidae, Ctenopelmatinae). Nat. Can. 108:17-56.

Baum, B. R.; Petruk, W.; Bailey, L. G. 1980. Assessment of the value of endospermic starch granules for the taxonomy of barley (*Hordeum*) species and cultivars with special emphasis on their identification, using the technique of image analysis. Z. Pflanzenzuecht. 85:212-225.

Baum, B. R.; Tulloch, A. P.; Bailey, L. G. 1980. A survey of epicuticular waxes among genera of Triticeae. I. Ultrastructure of glumes and some leaves as observed with the scanning electron microscope. Can. J. Bot. 58(23):2467-2480.

Bright, D. E. 1980. Studies on the Xyleborini 1. Three new species of *Schedlia* from New Guinea (Coleoptera: Scolytidae). Coleopt. Bull. 34(4):369-372.

Bright, D. E. 1981. *Afrotrypetus*, a new genus of bark beetles from Africa (Coleoptera: Scolytidae). Coleopt. Bull. 35(1):113-116.

Bright, D. E. 1981. Eye reduction in a cavernicolous population of *Coccotrypes dactylipdera* Fabricius (Coleoptera: Scolytidae). Coleopt. Bull. 35(1):117-120.

Bright, D. E. 1981. Studies on West Indian Scolytidae (Coleoptera) I. New species, new distribution records and taxonomic notes. Stud. Neotrop. Fauna Environ. 16:151-164.

Bright, D. E. 1981. Taxonomic monograph of the genus *Pityophthorus* Eichoff in North and Central America (Coleoptera: Scolytidae). Mem. Entomol. Soc. Can. 118:1-378.

Byers, J. R.; Underhill, E. W.; Steck, W. F.; Chisholm, M. D.; Teal, P. E. A. 1981. Biosystematics of the genus *Euxoa* (Lepidoptera: Noctuidae) XV. Sex pheromone cross attractancy among the three closely related species of the *Declarata* group. Can. Entomol. 113:235-243.

Campbell, J. M. 1980. A revision of the genus *Carphacis* des Gozis (Coleoptera: Staphylinidae) of North America. Can. Entomol. 112:935-953.

Campbell, J. M. 1980. Distribution patterns of Coleoptera in eastern Canada. Can. Entomol. 112:1161-1175.

Campbell, J. M. 1980. Insects of Saudi Arabia. Coleoptera: Fam. Alleculidae. Fauna Saudi Arabia. 2:133-136.

Catling, P. M. 1981. Taxonomy of autumn-flowering *Spiranthes* species of southern Nova Scotia. Can. J. Bot. 59(7):1253-1270.

Cavers, P. B.; Bassett, I. J.; Crompton, C. W. 1980. The biology of Canadian weeds. 47. *Plantago lanceolata* L. Can. J. Plant Sci. 60:1269-1282.

Cody, W. J.; Wagner, V. 1981. The biology of Canadian weeds. 49. *Equisetum arvense* L. Can. J. Plant Sci. 61:123-133.

Corlett, M. 1981. A taxonomic survey of some species of *Didymella* and *Didymella*-like species. Can. J. Bot. 59:2016-2042.

Dondale, C. D.; Redner, J. H. 1980. Description of a new wolf spider in the genus *Pirata* (Araneae: Lycosidae). Psyche 87(3-4):193-197.

Dondale, C. D.; Redner, J. H. 1981. Classification of two North American species of *Pirata*, with a description of a new genus (Araneae, Lycosidae). Bull. Am. Mus. Nat. Hist. 170(1):106-110.

Ebsary, B. A. 1981. Generic revision of Criconematidae (Nematoda): *Crossonema* and related genera with a proposal for *Neocrossonema* n. gen. Can. J. Zool. 59(1):103-114.

Ebsary, B. A. 1981. Two new species of *Macroposthonia* (Nematoda: Criconematidae) from Canada. Can. J. Zool. 59(1):115-118.

Ebsary, B. A. 1981. *Notholetus spicatus* n. gen., n. sp. (Nematoda: Criconematidae) from Hawaii. Can. J. Zool. 59(4):637-638.

Ebsary, B. A. 1981. Generic revision of Criconematidae (Nematoda): *Nothocriconema* and related genera with proposals for *Nothocriconemella* n. gen. and *Paracriconema* n. gen. Can. J. Zool. 59(7):1227-1236.

Ebsary, B. A. 1981. *Neobakernema* n. gen. (Nematoda: Criconematidae) with an emendation of *Bakernema* Wu, 1964. Can. J. Zool. 59(11):2215-2216.

Ebsary, B. A.; Eveleigh, E. S. 1981. *Eutylenchus excretorius* n. sp. (Nematoda: Atylenchidae) from Quebec, Canada. Can. J. Zool. 59(10):1973-1975.

Eveleigh, E. S.; Chant, D. A. 1981. Experimental studies on acarine predator–prey interactions: Effects of predator age and feeding history on prey consumption and the functional response (Acarina: Phytoseiidae). Can. J. Zool. 59(7):1387-1406.

Eveleigh, E. S.; Chant, D. A. 1981. Experimental studies on acarine predator–prey interactions: The numerical response of immature and adult predators (Acarina: Phytoseiidae). Can. J. Zool. 59(7):1407-1418.

Eveleigh, E. S.; Chant, D. A. 1981. The feeding and searching behaviour of two species of phytoseiid mites, *Phytoseiulus persimilis* Athias-Henriot and *Amblyseius degenerans* (Berlese), at different prey densities (Acarina: Phytoseiidae). Can. J. Zool. 59(7):1419-1430.

Goulet, H. 1981. New external distinguishing characters for the sawflies *Gilpinia hercyniae* and *G. polytoma* (Hymenoptera: Diprionidae). Can Entomol. 113:769-771.

Goulet, H. 1981. Distinguishing external features of adult males and females of North American species of *Phymatocera* Dahlbom (Hymenoptera: Tenthredinidae) and their phylogeny. Can. Entomol. 113:801-806.

Greenhalgh, R.; Baum, B. R. 1980. Feasibility study of the identification of cultivars by pyrolysis gas chromatography using oat (*Avena*) seed kernels. Seed Sci. Technol. 8:407-414.

Hamilton, K. G. A. 1980. Aphrophorinae of Polynesia (Rhynchota: Homoptera: Cercopidae). Pac. Insects 22(3):347-360.

Hamilton, K. G. A. 1980. Aphrophorinae of the Solomon Islands (Rhynchota: Homoptera: Cercopidae). Pac. Insects 22(3-4):361-379.

Hamilton, K. G. A. 1980. Contributions to the study of the world Macropsini (Rhynchota: Homoptera: Cicadellidae). Can. Entomol. 112:875-932.

Hudson, A. 1981. Distinguishing characters of the reproductive system and genitalia of *Xestia dolosa* and *Xestia adela* (Lepidoptera: Noctuidae). Proc. Entomol. Soc. Wash. 83(3):413-420.

Hughes, S. J. 1980. New Zealand fungi 30. *Cirrosporium novae-zelandiae* gen. nov., sp. nov. N.Z. J. Bot. 18:329-333.

Hughes, S. J. 1981. Mucronate hyphopodia of Meliolaceae are phialides. Can. J. Bot. 59(8):1514-1517.

Hughes, S. J. 1981. New Zealand fungi 31. Capnobotrys, an anamorph of Metacapnodiaceae. N.Z. J. Bot. 19:193-226.

Kelton, L. A. 1980. First record of a European bug, *Loricula pselaphiformis* Curtis in the Nearctic region (Heteroptera: Microphysidae). Can. Entomol. 112:1085-1087.

LeSage, L.; Harrison, A. D. 1981. Observations on the diversity, flight periods, emergence, swarming, and microdistribution of crane-flies at Salem Creek, Ontario (Diptera: Tipulidae, Ptychopteridae, and Trichoceridae). Aquat. Insects 3(2):81-97.

LeSage, L.; Harrison, A. D. 1981. Taxonomy of *Cricotopus* species (Diptera: Chironomidae) from Salem Creek, Ontario. Proc. Entomol. Soc. Ont. 111:57-114.

Levanidova, I. M.; Schmid, F. 1981. Considerations on *Archithremma ulachensis* Martynov (Trichoptera, Limenlphilidae). Aquat. Insects 3(2):65-73.

Lowrie, D. C.; Dondale, C. D. 1981. A revision of the *nigra* group of the genus *Pardosa* in North America (Araneae, Lycosidea). Bull. Am. Mus. Nat. Hist. 170(1):125-139.

Luther, B. S.; Redhead, S. A. 1981. *Crepidotus cinnabarinus* in North America. Mycotaxon 12(2):417-430.

Marriage, P. B.; Khan, S. U.; Warwick, S. I.; Tutte, D. F. 1981. Differential nitrogen response to atrazine of susceptible and resistant populations of lamb's-quarters (*Chenopodium album* L.). Pestic. Biochem. Physiol. 15:294-299.

Masner, L. 1980. The nearctic species of *Acerotella* Masner (Hymenoptera, Proctotrupoidea, Platygastridae). Can. Entomol. 112:1291-1303.

Masner, L. 1981. *In* Townes, H.; Townes, M., eds. A revision of the Serphidae (Hymenoptera). Mem. Am. Entomol. Inst. 32:11-16.

Mason, W. R. M. 1981. Paxylommatidae: The correct family-group name for *Hybrizon* Fallén (Hymenoptera: Ichneumonoidae), with figures of unusual antennal sensilla. Can. Entomol. 113:433-439.

Mason, W. R. M. 1981. The polyphyletic nature of *Apanteles* Foerster (Hymenoptera: Braconidae): A phylogeny and reclassification of Microgastrinae. Mem. Entomol. Soc. Can. 115:1-147.

McAlpine, J. F., et al. 1981. Introduction; Chapter 2, Morphology and terminology—adults; Chapter 4, Key to families—adults. *In* Manual of Nearctic Diptera, Volume 1. Agric. Can. Monogr. 27. 674 pp.

McAlpine, J. F. 1981. *Morgea freidbergi* new species, a living sister-species of the fossil species *M. mcalpinei*, and a key to world genera of Pallopteridae (Diptera). Can. Entomol. 113:81-91.

McAlpine, J. F.; Slight, C. 1981. The wheat bulb fly, *Delia coarctata*, in North America (Diptera: Anthomyiidae). Can. Entomol. 113:615-621.

McNeill, J. 1980. The biology of Canadian weeds. 46. *Silene noctiflora* L. Can. J. Plant Sci. 60:1243-1253.

McNeill, J. 1981. Nomenclatural problems in *Polygonum*. Taxon 30(3):630-641.

McNeill, J. 1981. Typification of generic names. Taxon 30(2):457-463.

McNeill, J.; Prentice, H. C. 1981. *Silene pratensis* (Rafn) Gordon & Gren., the correct name for white campion or white cockle (*Silene alba* (Miller) E. H. L. Krausse, Nom. Illeg.). Taxon 30(1):27-32.

Mulligan, G. A.; Munro, D. B. 1980. The biology of Canadian weeds. 48. *Cicuta maculata* L., *C. douglasii* (DC.) Coult. & Rose and *C. virosa* L. Can. J. Plant Sci. 61:93-105.

Mutuura, A. 1980. A new species of *Clepsis* Guenée from the Northern Yukon Territory (Lepidoptera: Tortricidae). Can. Entomol. 112:1071-1073.

Neish, G. A. 1981. *Fusarium moniliforme* var. *intermedium*, a new variety in Liseola section. Can. J. Bot. 59(3):288-291.

Oliver, D. R. 1981. Chapter 29. Chironomidae. *In* Manual of Nearctic Diptera. Volume 1. Agric. Can. Monogr. 27. 674 pp.

Oliver, D. R. 1981. Description of *Euryhapsis* new genus including three new species (Diptera: Chironomidae). Can. Entomol. 113:711-722.

Oliver, D. R.; Smith, I. M. 1980. Host associations of some pionid mite larvae (Acari: Prostigmata: Pionidae) parasitic on chironomid imagos (Diptera: Chironomidae). Acta Univ. Carolinae - Biol. 1978 12:157-162.

Parmelee, J. A.; Savile, D. B. O. 1981. Autoecious species of *Puccinia* on Cichorieae in North America. Can. J. Bot. 59(6):1078-1101.

Peterson, B. V. 1981. Introduction (with McAlpine, J. F., et al.); Chapter 19, Anisopodidae; Chapter 21, Synneuridae (with Cook, E. F.); Chapter 26, Thaumaleidae (with Stone, A.); Chapter 27, Simuliidae; Chapter 41, Apioceridae. *In* Manual of Nearctic Diptera, Volume 1. Agric. Can. Monogr. 27. 674 pp.

Porsild, A. E.; Cody, W. J. 1980. Vascular plants of continental Northwest Territories, Canada. Natl. Mus. Nat. Sci. Publ. 667.

Redhead, S. A. 1981. Parasitism of bryophytes by agarics. Can. J. Bot. 59(1):63-67.

Redhead, S. A. 1981. Agaricales on wetland Monocotyledoneae in Canada. Can. J. Bot. 59(5):574-589.

Redhead, S. A.; Singer, R. 1981. *Resinomycena* gen. nov. (Agaricales), an ally of *Hydropus, Mycena,* and *Baeospora.* Mycotaxon 13:150-170.

Redhead, S. A.; Smith, J. D. 1981. A North American isolate of *Coprinus kubickae* associated with a superficial fairy ring. Can. J. Bot. 59(3):410-414.

Redhead, S. A.; Spicer, K. W. 1981. *Discinella schimperi,* a circumpolar parasite of *Sphagum squarrosum* and notes on *Bryophytomyces.* Mycologia 73:904-913.

Redhead, S. A.; Traquair, J. A. 1981. *Coprinus* sect. Herbicolae from Canada, notes on extralimital taxa, and the taxonomic position of a low temperature basidiomycete forage crop pathogen from western Canada. Mycotaxon 13:373-404.

Savile, D. B. O. 1980. Ecology, convergent evolution, and classification in Uredinales. Rep. Tottori Mycol. Inst. Jap. 18:275-281.

Savile, D. B. O. 1981. The supposed rust of *Echinochloa.* Mycologia 73(5):1007-1008.

Schmid, F. 1980. Esquisse pour une classification et une phylogénie des Goérides (Trichoptera). Nat. Can. 107:185-194.

Schmid, F. 1981. Revision des Trichoptères canadiens. 1. La famille des Rhyacophilidae (Annulipalpia). Mem. Entomol. Soc. Can. 116:1-83.

Shewell, G. 1981. Introduction (with McAlpine, J. F., et al.). *In* Manual of Nearctic Diptera, Volume 1. Agric. Can. Monogr. 27. 674 pp.

Shoemaker, R. A.; Simpson, J. A. 1981. A new species of *Pestalosphaeria* on pine with comments on the generic placement of the anamorph. Can. J. Bot. 59(6):986-991.

Small, E. 1981. A numerical analysis of morphogeographic groups of cultivars of *Humulus lupulus* based on samples of cones. Can. J. Bot. 59(3):311-324.

Small, E. 1981. A numerical analysis of major groupings in *Medicago* employing traditionally used characters. Can. J. Bot. 59(9):1553-1577.

Small, E.; Crompton, C. W.; Brookes, B. S. 1981. The taxonomic value of floral characters in tribe Trigonelleae (Leguminosae), with special reference to *Medicago.* Can. J. Bot. 59(9):1578-1598.

Small, E.; Lefkovitch, L. P.; Brookes, B. S. 1981. Remarkable asymmetries in trifoliolate leaves with particular reference to *Medicago.* Can. J. Bot. 59(5):662-671.

Smetana, A. 1980. Review of Mexican species of the genus *Nudobius* C.G. Thomson (Col., Staphylinidae). Coleopt. Bull. 34(2):159-166.

Smetana, A. 1981. A new species of the genus *Phloeonomus* Heer from the Kuril Islands (Coleoptera: Staphylinidae). Entomol. Scand. 12:78-80.

Smetana, A. 1981. *Neophyphus vilis* (Sharp)—Taxonomy and lectotype designation (Coleoptera, Staphylinidae). Coleopt. Bull. 34(4):385-387.

Smetana, A. 1981. *Ontholestes murinus* (Linné 1758) in North America (Coleoptera: Staphylinidae). Coleopt. Bull. 35(1):125-126.

Smetana, A. 1981. A new genus and species of Quediini from Chile (Coleoptera: Staphylinidae). Can. Entomol. 113:349-364.

Smetana, A. 1981. Revision of the tribe Quediini of America north of Mexico (Coleoptera: Staphylinidae). Suppl. 5. Can. Entomol. 113:631-644.

Smetana, A.; Campbell, J. M. 1980. A new genus and two new philoeocharine species from the Pacific Coast of North America (Coleoptera: Staphylinidae). Can. Entomol. 112:1061-1069.

Teskey, H. J. 1981. Introduction (with McAlpine, J. F., et al.); Chapter 3, Morphology and terminology—larvae; Chapter 30, Pelecorhynchidae; Chapter 31, Tabanidae (with Pechuman, L. L.); Chapter 39, Vermileonidae; Chapter 44, Nemestrinidae. *In* Manual of Nearctic Diptera, Volume 1. Agric. Can. Monogr. 27. 674 pp.

Tidwell, M. A.; Peterson, B. V.; Ramirez-Perez, J.; Tidwell, M. A.; Lacey, L. A. 1981. Notas y claves preliminares de los jejenes neotropicales pertenecientes a los grupos *Simulium amazonicum* y *S. sanguineum* (Diptera: Simuliidae) incluyendo los vectores de *Onchocerca volvulus* y *Mansonella ozzardi.* Bol. Dir. Malariol. San. Amb. 21(2):79-89.

Tidwell, M. A.; Tidwell, M. A.; Peterson, B. V. 1981. A redescription of the female of *Simulium sanguineum* Knab and descriptions of the male, pupa, and larva (Diptera: Simuliidae). Proc. Entomol. Soc. Wash. 83(1):13-27.

Vockeroth, J. R. 1981. Introduction (with McAlpine, J. F., et al.); Chapter 14, Mycetophilidae; Chapter 17, Psychodidae (with Quate, L. W.); Chapter 48, Dolichopodidae (with Robinson, H.). *In* Manual of Nearctic Diptera, Volume 1. Agric. Can. Monogr. 27. 674 pp.

Warwick, S. I. 1980. Differential growth between and within triazine-resistant and triazine-susceptible biotypes of *Senecio vulgaris* L. Weed Res. 20:299-303.

Warwick, S. I. 1980. The genecology of lawn weeds. VII. The response of different growth forms of *Plantago major* L. and *Poa annua* L. to simulated trampling. New Phytol. 85:461-469.

Warwick, S. I.; Black, L. 1980. Uniparental inheritance of atrazine resistance in *Chenopodium album* L. Can. J. Plant Sci. 60:751-753.

Warwick, S. I.; Black, L. 1981. The relative competitiveness of atrazine susceptible and resistant populations of *Chenopodium album* and *C. strictum*. Can. J. Bot. 59(5):689-693.

Warwick, S. I.; Briggs, D. 1980. The genecology of lawn weeds. IV. Adaptive significance of variation in *Bellis perennis* L. as revealed in a transplant experiment. New Phytol. 85:275-288.

Warwick, S. I.; Briggs, D. 1980. The genecology of lawn weeds. V. The adaptive significance of different growth habit in lawn and roadside populations of *Plantago major* L. New Phytol. 85:289-300.

Warwick, S. I.; Briggs, D. 1980. The genecology of lawn weeds. VI. The adaptive significance of variation in *Achillea millefolium* L. as investigated by transplant experiments. New Phytol. 85:451-460.

Warwick, S. I.; Hamill, A. S.; Marriage, P. B. 1980. Response of different growth forms of *Poa annua* L. (annual bluegrass) to herbicides applied before or after emergence. Can. J. Plant Sci. 60:947-952.

Warwick, S. I.; Weaver, S. E. 1980. Atrazine resistance in *Amaranthus retroflexus* (redroot pigweed) and *A. powellii* (green pigweed) from southern Ontario. Can. J. Plant Sci. 60:1485-1488.

Wood, D. M. 1981. Introduction (with McAlpine, J. F., et al.); Chapter 11, Axymiidae; Chapter 12, Pachyneuridae. *In* Manual of Nearctic Diptera, Volume 1. Agric. Can. Monogr. 27. 674 pp.

Yoshimoto, C. M. 1980. Synopsis of *Chrysonotomyia* Ashmead s. str. of America north of Mexico (Hymenoptera: Chalcidoidea, Eulophidae). Can. Entomol. 112:1039-1048.

Miscellaneous

Barr, D. J. S. 1981. *Polymyxa graminis*. Fungi Can. No. 199.

Barr, D. J. S. 1981. *Polymyxa betae*. Fungi Can. No. 200.

Baum, B. R.; Thompson, B. K.; Bailey, L. G.; Brown, B. 1981. Barley register (a first report). Res. Branch, Agric. Can., Ottawa, Ont.

Bright, D. E. 1981. A new synonym of *Agrilus sayi* (Coleoptera: Buprestidae). Can. Entomol. 113:871.

Brown, J. R.; Catling, P. M. 1981. The status and distribution of yellow ladies'-tresses orchid (*Spiranthes ochroleuca* (Rydb.) Rydb.) in Ontario. Ont. Field Biol. 35(1):7-12.

Cody, W. J. 1981. Book review: Vascular flora of the southeastern United States: Volume I. Asteraceae. Can. Field-Nat. 95:119.

Cody, W. J. 1981. Book review: Bibliography of the natural history of Newfoundland and Labrador. Can. Field-Nat. 95:382.

Cody, W. J. 1981. Book review: The vegetation and phytogeography of coastal southwestern James Bay. Ont. Field Biol. 34:108.

Cook, F. R.; Lafontaine, J. D.; Black, S.; Luciuk, L.; Lindsay, R. V. 1980. Spotted turtles (*Clemmys guttata*) in eastern Ontario and adjacent Quebec. Can. Field-Nat. 94(4):411-415.

Corlett, M.; Egger, K. N. 1981. *Venturia adusta*. Fungi Can. No. 194.

Ginns, J. 1981. Review of: Flore des champignons au Québec et régions limitrophes, *by* Pomerleau, R. Can. Field-Nat. 95:381-382.

Ginns, J. 1981. Review of: The resupinate nonporoid Aphyllophorales of the temperate northern hemisphere, *by* Julich, W.; Stalpers, J. Mycologia 73:1018-1019.

Hughes, S. J. 1981. *Phragmocephala stemphylioides* var. *stemphylioides*. Fungi Can. No. 191.

Hughes, S. J. 1981. *Phragmocephala stemphylioides* var. *parva*. Fungi Can. No. 192.

Hughes, S. J. 1981. *Phragmocephala prolifera*. Fungi Can. No. 193.

Hughes, S. J. 1981. Book review: The whole fungus—the sexual asexual synthesis. *Edited by* Kendrick, B. Can. Field-Nat. 95:222-223.

Hughes, S. J.; Hiratsuka, Y. 1981. *Capnobotrys sessilispora*. Fungi Can. No. 201.

Kendall, D. M.; Kevan, P. G.; Lafontaine, J. D. 1981. Nocturnal flight activity of moths (Lepidoptera) in alpine tundra. Can. Entomol. 113:607-614.

Lafontaine, J. D. 1981. Book review: A revision of the Armandini (Lepidoptera, Noctuidae), *by* Wiltshire, E. P. Entomol. Soc. Am. Bull. 27(1):91-92.

Mason, W. R. M. 1981. Book review: Hymenoptera, Braconidae (Opiinae II. Amerika) Das Tierreich 96, *by* Fischer, M. Entomol. Gen. 6:270.

Mason, W. R. M. 1981. Book review: Review of Nearctic Alysiini (Hymenoptera, Braconidae), *by* Wharton, R. Bull. Entomol. Soc. Can. 13:60.

McNeill, J. 1981. Apera, silky-bent or windgrass, an important weed genus recently discovered in Ontario, Canada. Can. J. Plant Sci. 61:479-485.

McNeill, J. 1981. Report of the committee on generic typification. Taxon 30(1):200-207.

Parmelee, J. A. 1981. *Puccinia dayi*. Fungi Can. No. 204.

Parmelee, J. A. 1981. *Puccinia limosae*. Fungi Can. No. 207.

Parmelee, J. A. 1981. *Puccinia ortonii*. Fungi Can. No. 208.

Parmelee, J. A. 1981. *Puccinia volkartiana*. Fungi Can. No. 210.

Parmelee, J. A.; de Carteret, P. M. 1981. *Puccinia distichlidis*. Fungi Can. No. 205.

Parmelee, J. A.; de Carteret, P. M. 1981. *Puccinia karelica*. Fungi Can. No. 206.

Parmelee, J. A.; de Carteret, P. M. 1981. *Puccinia subnitens*. Fungi Can. No. 209.

Redhead, S. A.; Traquair, J. A. 1981. *Calyptella capula*. Fungi Can. No. 202.

Savile, D. B. O. 1981. *Ustilago pinguiculae*. Fungi Can. No. 198.

Savile, D. B. O. 1981. A naturalist looks at arctic adaptations. Scudder, G. G. E.; Reveal, J. L., eds. Evolution today. Proc. 2nd Int. Cong. Syst. Evol. Biol. pp. 47-53.

Shoemaker, R. A. 1981. Changes in taxonomy and nomenclature of important genera of plant pathogens. Annu. Rev. Phytopathol. 19:297-307.

Shoemaker, R. A.; Egger, K. N. 1981. *Lophodermium malaleucum*. Fungi. Can. No. 195.

Shoemaker, R. A.; Egger, K. N. 1981. *Lophodermium maculare*. Fungi Can. No. 196.

Shoemaker, R. A.; Egger, K. N. 1981. *Lophodermium sphaeriodies*. Fungi Can. No. 197.

Small, E.; Dumanski, J.; Lendavy-Zwickl, J., editors. 1981. Climate and soil requirements for economically important crops in Canada. Agric. Can. Publ. 55 pp.

Stirton, C. D.; Field, D. V.; Brummitt, R. K.; McNeil, J. 1981. Principles of lectotypification. Taxon 30(1):251-256.

Chemistry and Biology Research Institute
Ottawa, Ontario

PROFESSIONAL STAFF

A. I. DE LA ROCHE, B.Sc., M.S., Ph.D.	Director
S. U. KHAN, B.Sc., M.Sc., Ph.D., F.C.I.C., F.R.I.C.	Assistant Director
D. BRUNETTE	Administrative Officer

Soil Chemistry and Biology

M. SCHNITZER, B.Sc. (Agr.), M.Sc., Ph.D., F.C.S.S., F.A.S.A., F.S.S.S.A.	Program Leader, Soil organic matter
Y. K. CHAN, B.Sc., Ph.D.	Soil nitrogen
M. IHNAT, B.Sc., Ph.D.	Analytical chemistry
K. C. IVARSON, B.Sc., M.Sc., Ph.D.	Soil microbiology
N. M. MILES, B.Sc.	Soil mineralogy
L. PURDIE, B.Sc., M.Sc., Ph.D.	Soil nitrogen
G. J. ROSS, B.S.A., M.Sc., Ph.D.	Soil mineralogy
S. S. SINGH, B.Sc., M.Sc., Ph.D.	Soil chemistry

Winterhardiness

M. K. POMEROY, B.Sc., M.Sc., Ph.D.	Program Leader; Winter survival of cereals
C. J. ANDREWS, B.Sc., Ph.D.	Winter survival of cereals
Y. CLOUTIER, B.Sc., M.Sc., Ph.D.	Desiccation stress
E. F. SCHNEIDER, B.S., M.Sc., Ph.D.	Snow mold damage
J. SINGH, B.S., Ph.D.	Freezing injury—membranes

Symbiotic Nitrogen Fixation

R. W. MILLER, B.S., Ph.D	Program Leader; Rhizobium physiology and enzymology
L. R. BARRAN, B.Sc., M.Sc., Ph.D.	Genetic engineering
R. M. BEHKI, B.Sc., M.Sc., Ph.D.	Genetic engineering
S. M. LESLEY, B.Sc., M.A., Ph.D.	Inoculant improvement
F. D. H. MACDOWALL, B.Sc., M.Sc., Ph.D.	Plant physiology

C. Preston, B.Sc., M.Sc., Ph.D.	Nitrogen cycle
J. C. Sirois, B.A., B.Sc., M.Sc., Ph.D.	Plant physiology
I. L. Stevenson, B.S.A., M.S.A., Ph.D.	Microbiology
R. J. Watson, B.Sc., M.Sc., Ph.D.	Genetic engineering

Environmental Chemistry

S. U. Khan, B.Sc., M.Sc., Ph.D., F.C.I.C., F.R.I.C.	Program Leader; Herbicides
D. S. Gamble, B.Sc., M.Sc., Ph.D., F.C.I.C.	Herbicide chemistry

Mycotoxins

R. Greenhalgh, B.S., Ph.D.	Program Leader; Analytical and natural products chemistry
C. Madhosingh, D.I.C.T.A., B.S.A., M.S.A., Ph.D.	Microbiology
J. C. Young, B.Sc., M.Sc., Ph.D.	Analytical and natural products chemistry

Virus and Mycoplasma

R. C. Sinha, B.Sc., M.Sc., Ph.D., D.Sc.	Program Leader; Virus and mycoplasma vector relationships
L. N. Chiykowski, B.S.A., M.Sc., Ph.D.	Leafhopper-transmitted mycoplasma
Y. C. Paliwal, B.S.A., M.Sc., Ph.D.	Aphid- and mite-transmitted viruses

Analytical Chemistry Services

M. Ihnat, B.Sc., Ph.D.	Head of Services

Electron Microscope Centre

I. L. Stevenson, B.S.A., M.S.A., Ph.D.	Program Leader
G. H. Haggis, B.Sc., Ph.D.	Electron microscopy

Honorary Research Associate

D. Siminovitch, B.Sc., M.Sc., Ph.D., F.R.S.C.	Frost hardiness

Departures

C. Madhosingh, D.I.C.T.A., B.S.A., M.S.A., Ph.D. Seconded to Research Branch Headquarters	Plant pathology
S. P. Mathur, B.Sc., Assoc. I.A.R.I., Ph.D. Transferred to Land Resource Research Institute, Ottawa, Ont.	Organic soils

E. A. Peterson, B.Sc., M.S., Ph.D. Retired October 1981	Bacteriology
R. B. Pringle, B.S., M.Sc., Ph.D., F.A.A.A.S. Retired October 1981	Host-specific toxins
D. Siminovitch, B.Sc., M.Sc., Ph.D., F.R.S.C. Retired May 1981	Frost hardiness

VISITING SCIENTISTS

N. Benhamou, B.Sc., M.Sc., Ph.D. National Research Council visiting fellow	Rickettsia mycoplasma
Y. Cloutier, B.Sc., M.Sc., Ph.D. National Research Council visiting fellow	Desiccation stress
B. E. Gudleifsson, Candidatus agr., Licensiat agr. Agricultural Research Institute, Iceland	Winter survival
A. H. Khadhair, B.S., M.Sc. Postgraduate student	Plant virology
P. Tremblay, B.Sc., Ph.D. National Research Council visiting fellow	Membrane biochemistry

INTRODUCTION

The activities of the Chemistry and Biology Research Institute (CBRI) are integrated into multidisciplinary, mission-oriented programs that have regional responsibility for research in basic and applied sciences related to agriculture. The activities are conducted under seven main programs, including a new mycotoxin program.

The research programs place particular emphases on the transformations and the management of soil nitrogen and organic matter, mineralogy, and the impact of acid rain on agricultural soils; the mechanisms of winterhardiness and the development of legumes and cereals more resistant to environmental stresses; the enhancement of inoculants and the improvement of host response to biologically fixed nitrogen; the environmental impact of pesticide residues; and the virus and mycoplasma diseases of crop plants and the development of rapid diagnostic methodology. A new program on fungal mycotoxins was instituted in 1981 to meet the concerns of the agri-food industry. Research in this program is centered on the development of analytical procedures for mycotoxin detection and methodologies for the production of large quantities of vomitoxin for animal feed trials.

The Electron Microscope Centre, Analytical Chemistry Services, and the Mineralogical Analytical Service maintained by CBRI continued to provide expertise and instrumentation analyses contributing to the research of Branch scientists across Canada in support of the full spectrum of Branch objectives. All services continued the development and implementation of improved methodologies to enhance their specific capabilities in responding to Branch program needs.

Highlights of 1981 include the successful isolation of the "unknown" soil nitrogen fractions that are the major components of the soil-N reservoir; the development of a more rapid and less costly test for the selection of winter cereals, which utilizes desiccation stress instead of cold acclimation; the development of methodologies for comparing the competitive ability of *Rhizobium meliloti* strains in field soils; the design of a light-integrating sphere for the nondestructive assessment of forage yields of individual plants; the demonstration that previously unknown and undetected "bound" pesticide residues cannot be excluded from environmental interactions and entry into the food chain; the successful isolation and purification of the causal mycoplasma of peach-X disease; and the rapid response of the newly formed mycotoxin program to the production, detection, and analyses of fungal toxins in food and feeds.

There was some realignment of CBRI programs to meet the new agricultural challenges identified during 1981. The mycotoxin program was instituted in response to the potential hazards of these fungal metaboloties. The biotechnology and other components of the nitrogen fixation program were strengthened, and new studies were initiated on the consequences of acid rain on soils and crops. The fungal disease program was discontinued in 1981 and the scientists were reassigned to the new priority areas.

This report summarizes only the highlights of our achievements in 1981. Reprints of research publications and copies of this report are available from the Chemistry and Biology Research Institute, Research Branch, Agriculture Canada, Ottawa, Ont. K1A 0C6.

A. I. de la Roche
Director

SOIL CHEMISTRY AND BIOLOGY

Soil chemistry and mineralogy

Reactions of $-SO_4$ ions in acid soils. The pH of soil suspensions and the degree of base saturation of soil samples equilibrated with $CaSO_4$ solutions were higher than those equilibrated with $CaCl_2$ solutions. The reduction in H^+ ions was proportional to the total H^+ ion activity of the soil suspensions. The speciation of Al in the presence of Cl^- ions differed from that in the presence of SO_4^{2-} ions. About 93% of the total Al occurred as Al(III) in $CaCl_2$ suspensions compared with 36% in $CaSO_4$ suspensions. In the latter about

60% of the total Al was present as $AlSO_4^+$, a mobile species that can migrate within the soil profile and leach into the aquatic environment. These data are relevant for explaining effects of acid rain, which contains SO_4^{2-} ions, on soil degradation.

Lepidocrocite in calcareous soils. For the first time, lepidocrocite (δ FeO.OH) was shown to occur in well-drained calcareous soils. In the past it was thought that this mineral was present only in anaerobic, poorly drained and acidic environments, and that such conditions were required for its crystallization. These findings prompt a revision of the current hypothesis.

Monomineralic halloysite. Mineralogical and chemical analyses established the occurrence of monomineralic halloysite, a hydrated kaolinite-like mineral, in the clay fraction of a Canadian soil undisturbed by glaciation. This finding is of particular significance to geomorphologists studying the age and history of quaternary land forms.

Gibbsite in a Nova Scotia soil profile. Four horizon samples from a soil profile in Nova Scotia were subjected to detailed mineralogical analyses in order to elucidate the formation of gibbsite. Most gibbsite was found in the finer fractions of the lower horizons. X-ray diffraction analyses and electron microscopic observations indicated that desilication was responsible for the formation of gibbsite via the following sequence of transformations: biotite → vermiculite → chlorite → kaolinite → gibbsite, and feldspar → kaolinite → gibbsite.

Infrared spectroscopy of minerals. In order to facilitate soil mineral identification 400 standard minerals related to those occurring in soils were selected for infrared (IR) analysis. Spectra of 225 of these minerals have been recorded to date.

Acid sulfate soils. In the presence of the iron-oxidizing bacterium *Thiobacillus ferrooxidans*, the ferrous-iron-containing mineral biotite undergoes alterations. This biological oxidation explains the often observed phenomenon of dissolution of the mineral during the formation of acid sulfate soils.

Soil organic matter

Chemistry of humic and fulvic acids. Metals in soils are often mobilized and transported as water-soluble metal–fulvic acid complexes. To obtain more detailed information on the chemical characteristics of such complexes, fulvic acid–Cu(II) and fulvic acid–Fe(III) complexes, with fulvic acid-to-metal ratios of 1:0.5 and 1:1, were prepared at pH's 4 and 6. After freeze-drying, each complex was characterized by chemical methods; IR, electron spin resonance (ESR), and Mössbauer spectroscopy; X-ray patterns; and thermal (DTA) methods. ESR data showed that substantial portions of the metals in the complexes formed inner-sphere complexes with fulvic acid. From X-ray patterns it appeared that the metals brought fulvic acid "molecules" closer together by bridging adjacent "molecules". The thermal stability of the fulvic acid decreased as it complexed with metals. Apparently the complexing of Cu and Fe exerted strains on the fulvic acid, thereby lowering its resistance to thermal decomposition. The data indicated that at least portions of the Cu and Fe were strongly complexed by the fulvic acid in divalent and trivalent forms, respectively.

The reactivity of humic materials is related to the shapes, sizes, and degrees of aggregation of humic acid and fulvic acid particles. Using transmission electron microscopy and a replica technique it was possible to delineate five major structural conformations of both fulvic and humic acids: small discrete spheroids (9–50 nm in diameter), flattened aggregates of spheroids (100–200 nm in diameter), flattened aggregates of spheroids (100–200 nm in diameter), linear chain-like assemblies of these larger aggregates, flattened filaments (15–150 nm in width), and perforated sheet-like structures. The concentrations of humic and fulvic acids in solution determined the type of structure that predominated. The prevalence of flexible linear structures in dilute aqueous solutions was clearly indicated. At higher concentrations of humic and fulvic acids, particles tended to coalesce to form aggregates. These findings explain long-term observations that dilute solutions of humic materials are more reactive than more concentrated ones. In dilute solutions more functional groups are exposed and available for interaction and there is less steric hindrance.

A number of humic and fulvic acids were characterized by solid-state ^{13}C-nuclear magnetic resonance (NMR) spectroscopy. Aromaticities of the humic materials calculated from the NMR spectral data ranged from 35 to 92%, in general agreement with earlier

estimates based on chemical oxidation and gas chromatography–mass spectrometry (GC–MS) studies. The importance of aliphatic structures in some humic materials was clearly indicated in some of the spectra. One anomaly observed was that phenolic carbons, generally considered major components of humic materials, did not produce intense NMR signals. It is possible that free radicals or inorganic components interfere with signals normally produced by phenolic carbons. Carboxyl carbons, by contrast, gave distinct signals.

"Unknown" soil nitrogen. About 50% of the total soil nitrogen has so far not been identified. To improve the efficiency of nitrogen use in soils, more must be known about this fraction. A novel procedure was developed for separating fractions from soils that contain between 97 and 99% of the "unknown" N. The procedure involves the extraction and separation of humic acid and fulvic acid fractions from several soils; hydrolysis of each fraction with hot 6 *N* HCl for 24 h; separation of neutralized hydrolysates on Sephadex G-25 gels; and further separation of the highest molecular weight fractions on G-50 gel, and of the second highest molecular weight fractions on G-15 gel. The separation of these fractions permits us to focus our attention on the identification of "unknown" N components without interference from the many known N compounds.

Another approach to the characterization of the "unknown" soil N consisted of synthesizing melanoidins by interacting carbohydrates with amino acids and examining the products. Solid-state ^{13}C-NMR spectra of the melanoidins were similar to that of a soil organic matter fraction separated from a Histosol.

Nitrogen availability. Work was continued on the nature and availability of soil nitrogen. Plant uptake, acid hydrolysis, and incubation were used to access the relative availability of residual fertilizer ^{15}N immobilized in the soil (Bainsville clay loam) in either clay-fixed ammonium or in organic forms. The results confirmed recent reports that fertilizer-derived clay-fixed ammonium is a relatively dynamic fraction, more available for plant uptake than residual fertilizer N in organic forms.

NMR spectroscopy of soils. Two studies were completed which demonstrated the considerable potential of NMR spectroscopy in soil investigations. ^{13}C-, ^{1}H-, and ^{15}N-NMR of benzoquinone polymers incorporating amino compounds provided information on the structure of these materials, which have been proposed as models for humic acid, and confirmed that N can be incorporated in forms resistant to acid hydrolysis. Solid-state ^{13}C-NMR of the humic acids, fulvic acids, humins, and hydrolysis residues of four soils showed that solid-state ^{13}C-NMR (a nondestructive technique requiring no sample preparation) showed distinct differences between fractions and provided useful structural information on these organic soil components.

Mineralogical analytical service

Thirty-five professional and technical staff of the Branch and four outside agencies made use of the X-ray diffraction, infrared, and Mössbauer analyses provided. The service contributed to studies on soil mineralogy, the microbiological formation of crystalline material, asbestos residues in water and building materials, mineralogical analyses of an internationally circulated geochemical standard shale, metal–organic complexes, soil classification, and new occurrences of soil minerals in Canada.

WINTERHARDINESS

Field and controlled-environment studies

Coldhardiness, ice encasement tolerance, and survival measurements of a series of genetically different winter cereal cultivars were determined throughout the winter and spring at seven sites at the Central Experimental Farm and on commercial farms in eastern and central Ontario. Survival was generally good at all but one site, where appreciable snow mold damage was observed. A field nursery at the Central Experimental Farm containing 91 lines of wheat and triticales from Ottawa and the University of Guelph was ice encased in January. Significant differential injury was observed and several ice-tolerant lines and cultivars were identified from this test. This ice testing program now screens material from the Canadian winterhardiness nursery and an increasing number of other plant-breeding establishments. Approximately 40 lines of winter wheat and triticales from the Ottawa Research Station wheat breeding program

were evaluated for freezing and ice encasement resistance.

Winter wheats are damaged more rapidly than timothy grass during ice encasement and this is associated with a more rapid decline in total nonstructural carbohydrates and a greater production of ethanol in wheat than in timothy. The toxicity of ethanol to timothy is also lower than to wheat. Maximum resistance to icing injury in several winter wheats was observed after 14 days warm pregrowth, a treatment that does not result in maximal coldhardiness. This finding permits greater accuracy in the selection of cultivars for increased icing resistance. Studies on coldhardening and dehardening responses of winter wheat infected with barley yellow dwarf virus showed that a short incubation period after infection, followed by 7 wk at low temperature, allows coldhardiness to return to control levels, but a longer virus incubation period reduces the subsequent coldhardening potential of wheat.

The respiration in a spring and winter wheat cultivar in both warm- and cold-grown plants increased linearly with increasing temperature. Whole plant photosynthesis, however, was dependent on growth temperature and varied between cultivars. Studies on carbon isotope discrimination in winter cereals revealed a significant decrease in $^{13}C/^{12}C$ fractionation in spring and winter wheats after cold acclimation.

Cells and membranes

Electron spin resonance spectroscopy studies on membranes of isolated rye cells revealed differences in probe motion changes between coldhardened and nonhardened cells during lethal freezing. Ultrastructural examination of rye and wheat cells during lethal freezing or plasmolysis stress indicated either that the membranes lose their unilamellar structure or fuse to form densely packed multilamellar vesicles. A comparison of leucine uptake by cells isolated from hardened and nonhardened winter rye indicated that cold acclimation did not alter the transport system of the plasma membrane to enable it to function more efficiently at low temperature. However, membrane transport properties of isolated winter wheat cells and protoplasts were adversely affected after only a few days exposure to ice encasement or ethanol.

Desiccation stress

Induction of freezing tolerance, comparable to that observed after a 4-wk cold acclimation period at 2°C, has now been induced in nine winter cultivars by a 24-h desiccation stress at 40% relative humidity. The two treatments also elicited similar increases in soluble proteins and phospholipids in shoots, suggesting that the one or more molecular mechanisms by which these stresses induce freezing and desiccation tolerance involve similar biochemical modifications.

Fungal pathogens

Studies on cell-wall composition and structure of conidia of *Fusarium sulphureum* showed that chitin microfibrils are synthesized by developing conidia but do not condense to form crystals, as in microfibrils of bacterial, fungal, and higher-plant cell walls. Conidogenesis in *Fusarium* follows a phialidic mode of development and only one cell wall, that of the conidium, is deposited during conidial development. Studies on root rot in lentils showed that a new isolate of *F. oxysporum* completely destroyed field plots of the crop by inciting a cortical root rot instead of the normal wilt associated with this species.

SYMBIOTIC NITROGEN FIXATION

Legume inoculants

Improvement of inoculants for forage legumes is a primary objective of the nitrogen fixation program. Previous results had shown that strains of *R. meliloti* cultured in the laboratory after isolation from field-grown alfalfa nodules were not competitive with wild strains when used to inoculate seedlings in the same soil, even when used at 100 times the equivalent of the recommended commercial seed inoculation rate. Indigenous *R. meliloti* formed nodules on alfalfa seedlings even though present at only 15 cells per gram of soil. The development of methods for distinguishing *R. meliloti* strains has been reported. The fact that inoculum cultured in the laboratory is not competitive implies that the cells have undergone a change that retards some aspect of the infection process. It has now been established that by distributing the inoculum evenly throughout 100-g soil samples, the number of nodules infected with the inoculum strain is proportional to the number of bacteria applied. For one strain inoculated

at the rate of 100 000 cells per gram of soil, 90% of the resulting nodules were due to this strain. Under these conditions it is now possible to compare inoculum strains of *R. meliloti* for competitive ability in field soil. An understanding of how the few indigenous strains successfully compete with a massive inoculation of a more effective laboratory-grown strain is required and modifications of inoculum preparation are now being examined since this may be a critical factor. Identification of genetic factors that may control competitive ability is also an important aspect of this work.

It is possible that lectins, small carbohydrate-binding proteins, are involved in the recognition process between legume root hairs and *Rhizobium* cells. A study of the binding of lectins to carbohydrates is being carried out with NMR spectroscopy in order to better characterize and optimize the binding of *Rhizobium* strains to root hairs. The infection of alfalfa roots by mycorrhizal fungi is being examined from the standpoint of possible effects on the nodular symbiotic nitrogen-fixing system. Methods were developed for the controlled mycorrhizal infection of alfalfa.

Rhizobium genetics

Research aimed at determining the linkage between *Rhizobium* genes responsible for nodulation and nitrogen fixation has been initiated. This work is focusing on the plasmid genetic elements that are known to carry these sets of genes. Over 100 *R. meliloti* isolates were screened for plasmid-associated traits, including antibiotic resistance and the ability to produce bacteriocidal proteins (bacteriocins). Methods for the direct detection of plasmids in these bacteria were required in order to catalog their plasmid complements. A technique was adopted that allows the detection of very large, fragile plasmids, including the "megaplasmid" that is thought to carry the genes for nitrogen fixation and symbiotic association. This plasmid was detected in all of 25 strains examined. It was usually accompanied by one to three smaller plasmid species.

A trait lacking in *R. meliloti*, which could increase the energy efficiency of nitrogen fixation in alfalfa, is the ability to recycle hydrogen gas produced as a by-product of the enzymatic reduction of dinitrogen. Intracellular localization of hydrogen-uptake (Hup) genes on a plasmid of a potential donor of the genes for this trait was carried out. *Alcaligenes eutrophus* mutants, isolated for their inability to grow under hydrogen gas, lacked the genes coding for soluble and membrane-bound hydrogenases. Analysis of isolated plasmid DNA from this organism indicated that the mutant cells had lost a plasmid. It was reintroduced into the mutants from the normal cells aided by a promiscuous plasmid (RK_2) and conjugative mating of mutant and wild-type cells. This procedure caused the mutants to regain the lost hydrogenase activity to the levels of the original parents. Experiments to verify the plasmid transfer of Hup genes by plasmid analysis of transconjugants are under way. The next step is to develop a system for transfer of the Hup genes to *R. meliloti*.

Rhizobium physiology

The physiological requirements for support of symbiotic nitrogen fixation by *Rhizobium* bacteroids in root nodules are not yet sufficiently characterized to allow contemplation of transfer of the capability for symbiotic nitrogen fixation to nonlegume hosts. Because considerable variation has been found in the nitrogen-fixing activity of various alfalfa cultivar–*Rhizobium* strain combinations, the physiological basis for this variation must be determined. A parameter proportional to the total reducing power available for reduction of dinitrogen was found to correlate closely with the dry weight yield of alfalfa grown on a zero-nitrogen medium.

It has been determined that the bacterial membrane is altered in several ways when free-living *R. meliloti* are converted to bacteroids in root nodules that fix nitrogen. The osmotic stability, permeability, and response to metal ions and the membrane electric potential of bacteroids are altered markedly as compared with free-living *Rhizobium* cells. The induction of these changes requires interaction with the host and they are not readily brought about outside the host cells. A supply of energy-rich metabolites must cross both a plant cell membrane and the altered bacterial membrance. Variation in the supply of metabolites as photosynthate was mainly responsible for an observed diurnal variation in nitrogenase activity in nodules. A 30-min lag was found between the production of photosynthate in the leaves of alfalfa seedlings and its use for driving the nitrogenase

reactions in the nodules. The delay was shown to be in the translocation process.

The subject of supply of photosynthate for nitrogen fixation and growth of forage legumes is under examination with the object of increasing the growth rates of these crops on symbiotically fixed nitrogen (low soil nitrogen). A rapid, nondestructive method of assessing forage yield of individual plants for screening purposes was developed in the form of a light-integrating sphere. The readout of light reflected by the chlorophyll centers was expressed as a function of chlorophyll content that was independent of the species of plant being measured. The chlorophyll contents were closely correlated with dry matter and gross photosynthetic activity, and the shape of these plots were specific to species, cultivar, and conditions of growth.

Twelve cultivars of alfalfa were used to determine the comparative growth kinetics on optimal levels of NO_3^- nitrogen and on symbiotically fixed nitrogen in zero-nitrogen media. Growth rate constants were found to be cultivar specific but all cultivars were subject to a morphogenetic change at the same time under optimal conditions. This change led to increased rates of growth on symbiotic N and lower soil nitrogen requirements. Attempts at defining whether this change is under genetic control in alfalfa or whether it can be induced at an early stage of growth are under way.

ENVIRONMENTAL CHEMISTRY

Bound pesticide residues

Bound ^{14}C-residues in an organic soil treated with uniformly ^{14}C-ring-labeled prometryn were distributed among various humic fractions. A considerable portion of ^{14}C-residues in humin and humic acid was composed of the parent compound and its mono-*N*-dealkylated metabolites. However, the soluble fulvic acid fraction contained an appreciable amount of the 2-hydroxy analog of prometryn. Thermoanalytic methods were used to obtain information on the nature and location of ^{14}C-bound residues in soil and humic materials. Bound ^{14}C-residues were released from moist soil when inoculated with microbes or exposed to ultraviolet light.

Leaching of herbicides in soil columns

The mobilities of four residual orchard herbicides, diuron, dichlobenil, simazine, and terbacil, were compared in a soil column using a sandy loam and loam soil common to the Okanagan Valley. Mobility of all herbicides was greater in the sandy loam than in the loam soil. Dichlobenil was the least mobile of the four chemicals tested and it appears to be the safest chemical to use for orchard-floor vegetation control under irrigation conditions for these two soil types.

Herbicide applications in a mature apple orchard

The herbicides simazine, terbacil, dichlobenil, and diuron used singly in one annual application under mature apple orchard trees resulted in excellent weed control, increased tree growth, and higher yields of fruit. However, results show that herbicide residues in soil may reach levels that could lead to tree injury. It is recommended that under eastern Ontario conditions, weed growth under mature trees be controlled by a rotation of herbicides rather than by annual applications of a single herbicide.

Airborne triallate residues in Saskatchewan

The maximum concentrations of the herbicide triallate in the air in Saskatchewan were found during the peak spraying season in May of each year. Concentrations decreased gradually by midsummer and increased somewhat again in the fall, corresponding with the limited fall application. After freeze-up of the soil in early November, the triallate levels in the air fell below the detection limit.

Hydrolysis of atrazine

Atrazine hydrolysis was measured by proton catalysis at 25.0°C, over the H^+ concentration range of 1.0×10^{-3} *M* to 1.0×10^{-2} *M*. The evidence obtained suggests that atrazine has two stages of protonation, each characterized by its own catalytic effect. Both stages may be related to atrazine decomposition in soils.

Nitrogen response to atrazine in lamb's-quarters

Populations of lamb's-quarters (*Chenopodium album* L.) and two pigweeds (*Amaranthus powellii* and *A. retroflexus*) susceptible and resistant to atrazine exhibited a differential response in regard to the concentration of

organic nitrogen in leaf tissue following atrazine treatment of young plants. Results suggest that an increase in nitrogen concentration in the plant occurred only when there was some degree of inhibition of photosynthesis by atrazine.

MYCOTOXINS

Vomitoxin and zearalenone

Methods were evaluated for the production of vomitoxin in amounts required for large-scale animal feeding trials and metabolic studies. The inoculation of field corn with local isolates of *Fusarium graminearum* was effective in producing average levels of vomitoxin (1142 μg/g). Higher concentrations of vomitoxin (3200 μg/g) were detected in badly infected cobs. Zearalenone was not detected in corn in these field-inoculation studies. The same *Fusarium* isolates were used for in vitro studies where the fungi were grown on corn and rice. Both vomitoxin and zearalenone were produced (maximum levels about 400 and 800 μg/g, respectively), the amounts depending upon the substrate, substrate water content, and incubation period.

High-performance liquid chromatographic methods sensitive to about 0.2 and 0.04 mg/kg were developed for analysis of vomitoxin and zearalenone, respectively, in corn and rice.

A thin-layer chromatographic method, sensitive to 20 μg/kg, was developed to screen for the presence of six mycotoxins including vomitoxin and zearalenone.

It was shown that the levels of vomitoxin and zearalenone in contaminated corn could be significantly reduced by treatment with various gases, including chlorine, ozone, and sulfur dioxide.

Ergot alkaloids

The variability in total and individual ergot alkaloid contents in triticale and barley sclerotia collected from different locations throughout Canada was determined. Comparison of these results with those from wheat and rye showed that for Central and Western Canada, the alkaloid composition of ergot is quite uniform, regardless of host and location. The average alkaloid content of Canadian ergot is about 0.24%. Differences in toxicity of ergot-contaminated feed is likely due more to variability in total alkaloid content than individual alkaloid composition.

Six-week feeding trials with growing swine showed that 0.1% dietary wheat or rye ergot reduced the average daily weight gain.

Chlorine and heat were found to be effective in achieving a 90% reduction in total alkaloid contents of treated ergot sclerotia. Autoclaving significantly reduced the toxic effect of dietary wheat ergot fed to poultry.

VIRUS AND MYCOPLASMA

Peach X-disease

Continuous cultures of *Paraphlepsius irroratus* (Say), a leafhopper vector of the disease, were established using a combination of clover and grass plants. The grass species were most suitable for nymphs, and clovers for adult leafhoppers. The disease was first transmitted to celery plants from naturally infected chokecherry shrubs by means of the leafhoppers. Using celery as the inoculum source, the disease was then transmitted to 11 new herbaceous host plants. Infected plants were shown to contain typical mycoplasma cells through electron microscopy. Also, the leafhoppers were able to acquire the disease agent from several infected herbaceous plant species and transmit it back to celery. The results suggest that several of these plant species, particularly those perennials found in the vicinity of peach orchards, may serve as reservoirs from which the leafhoppers could transmit the disease to peach. The mycoplasma associated with the disease was isolated and purified for production of the antiserum required for rapid disease diagnosis.

Forage legume diseases

Systemic infection by a rickettsia-like organism in white clover and dodder was characterized by localization of the pathogen in phloem sieve elements and by the presence of a granular material in infected cells—a diagnostic feature of the disease. The granular material was identified as a protein and the two membranes of the organism were shown to contain polysaccharides. A virus newly recognized in alfalfa in North America was identified as lucerne transient streak virus. In addition, several strains of alfalfa mosaic virus (AMV) were identified and weed plants serving as sources of the virus were determined. Seed transmission of AMV in two wild species of *Medicago* was demonstrated. In experimentally infected alfalfa, the

seed transmission rate of the virus was 8–31%, and commercial seed lots contained 0–16% infected seeds.

Aster yellows

Heterologous serological tests, using the immunodiffusion technique, showed that the mycoplasma of aster yellows is closely related to that of clover phyllody. The conditions of long-term cryopreservation of mycoplasmas, found associated with yellows-type diseases, in leafhoppers were established for seven vector–pathogen combinations.

Barley yellow dwarf virus

The incidence and strain types of the virus prevalent in winter wheat and perennial grasses were compared at five locations in Ontario and Quebec. Results suggest that winter wheat can serve as a virus source for spring grains but grasses are of little importance as sources of virus to cereal crops. Improved immunoelectron microscopy allowed, for the first time, rapid detection of the virus in a single aphid vector. This makes it possible to rapidly estimate the proportion of viruliferous aphids in a population. The virus was detectable in aphids exposed to infected plants for 1 day and in aphids removed from the virus source for at least 9 days.

ELECTRON MICROSCOPE CENTRE

Sixty-four professional and technical staff of the research institutes, five research stations, and ten outside agencies made use of the personnel and facilities of the Centre. The Postal Service responded to requests by research workers at the Regina, Harrow, St. Jean, Charlottetown, and St. John's West research stations and at L'Assomption experimental farm.

The Centre contributed to research papers concerned with methodology development, food structure, crystallization, and structure of soil complexes, soil cementing materials, phylogeny and classification (entomology, botany), pathological changes in plant tissues, detection of virus, mycoplasma, and Rickettsia-like organisms, eggshell microstructure, and zoospore ultrastructure. Particulars of these publications appear under the individual listings of institutes and stations.

In-house research projects included the development of methodologies for high-resolution scan microscopy of intracellular structures and the development of delayed-fixation techniques to determine the physical configuration of the DNA entities of chloroplasts and bacteria.

The Centre provided electron microscopy expertise for instruction at the Latin American School of Electron Microscopy, Maracaibo, Venezuela.

ANALYTICAL CHEMISTRY SERVICES

The Analytical Chemistry Service continued to provide Branch establishments with analyses in support of research projects in the areas of soil management and protection, land use, energy production and conservation, production improvement of dairy cattle and poultry, improvement of cereal, oilseed, forage, horticultural and field crops, food processing and new product development, and food safety. Priority analyses were provided regarding low-magnesium paralysis in cattle and copper intoxication of sheep.

Constituents determined included moisture, fat dietary fiber, lignin, cellulose, ash, caloric value, macro and trace elements, nitrogen, protein, amino acids, ethanol, carbohydrates, and organic functional groups. Approximately 75 000 analyses were provided to 115 scientific and technical staff of 20 Branch institutes and stations.

New methods for the measurement of sulfur, boron, and moisture contents were adapted and implemented during the year. Automation of methodologies and computerization of data storage, transmission, and transformation continued.

PUBLICATIONS

Research

Andrews, C. J.; Pomeroy, M. K. 1981. The effect of preflooding treatment on cold hardiness and survival of winter cereals in ice encasement. Can. J. Plant Sci. 61:507-513.

Barran, L. R. 1981. Glutamate transport by macroconidia of *Fusarium sulphureum*. Trans. Br. Mycol. Soc. 77:261-266.

Barran, L. R. 1981. Methionine transport by mycelia of *Fusarium oxysporum* f. sp. *lycopersici*. Can. J. Microbiol. 27:743-747.

Benzing-Purdie, L. 1981. Glucosamine and galactosamine distribution in a soil as determined by gas liquid chromatography of soil hydrolysates: Effect of acid strength and cations. Soil Sci. Soc. Am. J. 45:66-70.

Benzing-Purdie, L.; Carlo, D. J.; Perry, M. B. 1981. Specific capsular polysaccharide of type 46 *Streptococcus pneumoniae* (American Type 73). Infect. Immun. 32:1024-1027.

Chiykowski, L. N. 1981. Association of mycoplasma-like organisms with clover yellow edge disease. Can. J. Plant Pathol. 3:139-144.

Chiykowski, L. N. 1981. Epidemiology of diseases caused by leafhopper-borne pathogens. Pages 105-159 *in* K. Maramoroch and K. F. Harris, eds. Plant diseases and vectors: Ecology epidemiology. Academic Press, New York, N.Y.

Chiykowski, L. N.; Wolynetz, S. 1981. Susceptibility of oat cultivars to aster yellows isolates from Eastern Canada. Can. J. Plant Pathol. 3:53-57.

Cortez, J.; Schnitzer, M. 1981. Reactions of nucleic acid bases with inorganic soil constituents. Soil Biol. Biochem. 13:173-178.

De Kimpe, C. R.; Kodama, H.; Rivard, R. 1981. Hydrothermal formation of kaolinite-like product from amorphous alumino silicates. Clays Clay Miner. 29:446-450.

Foscolos, A. E.; Kodama, H. 1981. Mineralogy and chemistry of arctic desert soils on Ellef Ringnes Island, Arctic Canada. Soil Sci. Soc. Am. J. 45:987-993.

Gamble, D. S. 1981. Orthophosphoric acid: calculation of concentration quotients for the first ionization equilibrium at 25.0°C. Can. J. Chem. 59:1630-1635.

Ghosh, K.; Schnitzer, M. 1981. Effects of pH and neutral electrolyte concentration on free radicals in humic substances. Soil Sci. Soc. Am. J. 44:975-978.

Ghosh, K.; Schnitzer, M. 1981. Fluorescence excitation spectra and viscosity behavior of a fulvic acid and its copper and iron complexes. Soil Sci. Soc. Am. J. 45:25-29.

Greenhalgh, R.; Belanger, A. 1981. Persistence of carbofuran in humic mesosols and the effects of drying and storage on residue levels in soil sample. J. Agric. Food Chem. 29:231-235.

Grover, R.; Kerr, L. A.; Khan, S. U. 1981. Multidetector gas chromatographic determination and confirmation of airborne triallate residues in Saskatchewan. J. Agric. Food Chem. 29:1082-1084.

Haggis, G. H. 1981. Freeze-fracture followed by thaw-fix for examination of internal cell structure. Biomed. Res. 2(Suppl.):55-61.

Haggis, G. H. 1981. *Vicia faba* root slices examined after freeze-fracture and thaw fixation. J. Microsc. 121:245-251.

Haggis, G. H.; Bond, E. F. 1981. A new approach to the study of the *E. coli* nucleoid. J. Microsc. 122:15-22.

Heeney, H. B.; Warren, V.; Khan, S. U. 1981. Effects of annual repeat applications of simazine, diuron, terbacil, and dichlobenil in a mature apple orchard. Can. J. Plant Sci. 61:325-329.

Heeney, H. B.; Warren, V.; Khan, S. U. 1981. Effects of rotation of simazine, terbacil and dichlobenil in a mature apple orchard. Can. J. Plant Sci. 61:497-511.

Hidiroglou, M.; Ivan, M.; Ihnat, M. 1981. Silicon in plasma sheep. Am. J. Vet. Res. 42:138-139.

Hogue, E. J.; Khan, S. U.; Gaunce, A. P. 1981. Movement of four herbicides in soil columns. Can. J. Soil Sci. 61:401-407.

Huner, N. P. A.; Miller, R. W. 1981. Spin labelling of RUBP–carboxylase–oxygenase from Puma rye. I. Spectrosc. Lett. 13:635-648.

Ihnat, M. 1981. Analytical approach to the determination of copper, zinc, cadmium and lead in natural fresh waters. Int. J. Environ. Anal. Chem. 8:259-275.

Iqbal, R.; Siddiqui, I. R.; Rosa, N.; Benzing-Purdie, L. 1981. An Amadori compound from tobacco. Carbohydr. Res. 98:57-63.

Ivarson, K. C.; Ross, G. J.; Miles, N. M. 1981. Formation and properties of rubidium jarosite crystallized during the microbiological oxidation of ferrous iron at room temperature. Can. Mineral. 19:429-434.

Kerndorff, H.; Schnitzer, M. 1981. Sorption of metals on humic acid. Geochim. Cosmochim. Acta 44:1701-1708.

Khan, S. U. 1981. *N*-Nitrosoamine formation in soil from the herbicide glyphosate and its uptake by plants. Pages 275-287 *in* R. A. Scanlan and S. R. Tannenbaum, eds. *N*-Nitroso compounds, ACS Symp. Ser. 174, Washington, D.C.

Khan, S. U.; Ivarson, K. C. 1981. Microbiological release of unextracted (bound) residues from an organic soil treated with ^{14}C-prometryn. J. Agric. Food Chem. 29:1301-1303.

Kodama, H.; Foscolos, A. E. 1981. Occurrence of berthierine in Canadian arctic desert soils. Can. J. Mineral. 19:279-283.

Lévesque, M.; Mathur, S. P.; Morita, H. 1981. A feasibility study on the possible use of cellulose content for characterizing histosols. Comm. Soil Sci. Plant Anal. 12:415-425.

Marriage, P. B.; Khan, S. U.; Warwick, S. I.; Tutte, D. F. 1981. Differential nitrogen response to atrazine of susceptible and resistant populations of lamb's-quarters (*Chenopodium album* L.). Pestic. Biochem. Physiol. 15:294-299.

Mathur, S. P.; Preston, C. M. 1981. The effect of residual fertilizer copper on ammonification, nitrification and proteolytic population in some organic soils. Can. J. Soil Sci. 61:445-450.

McKeague, J. A.; Kodama, H. 1981. Imogolite in cemented horizons of some British Columbia soils. Geoderma 25:189-197.

McKeague, J. A.; Wang, C.; Ross, G. J.; Acton, C. J.; Smith, R. E.; Anderson, D.; Pettapiece, W. W.; Lord, T. M. 1981. Evaluation of criteria for argillic horizons (Bt) of soils in Canada. Geoderma 25:63-74.

McMurchie, E. J.; Pomeroy, M. K. 1981. Isolation and properties of ion-stimulated ATPase activity associated with cauliflower plasma membranes. Plant Physiol. 68:626-630.

Moody, R. I.; Weinberger, P.; Greenhalgh, R.; Massalski, A. 1981. Algicidal properties of the PC-solvent Aerotex 3470: growth, ATP synthesis and ultrastructure. Can. J. Bot. 59:1003-1013.

Morita, H.; Sowden, F. J. 1981. Effect of decomposition on the distribution of amino compounds in the acid hydrolysates of organic soils. Soil Biochem. 13:327-329.

Paliwal, Y. C.; Singh, R. P. 1981. Cytopathological changes induced by potato spindle tuber viroid in *Scopolia sinensis*. Can. J. Bot. 59:677-682.

Pomeroy, M. K.; Raison, J. K. 1981. Maintenance of membrane fluidity during development of freezing tolerance of winter wheat seedlings. Plant Physiol. 68:382-385.

Preston, C. M.; Mathur, S. P.; Rauthan, B. S. 1981. The distribution of copper, amino compounds and humus fractions in organic soils of differing copper content. Soil Sci. 131:344-352.

Rauthan, B. S.; Schnitzer, M. 1981. Effects of a soil fulvic acid on the growth and nutricnt content of cucumber (*Cucumis sativus*) plants. Plant Soil 63:491-495.

Read, D. C.; Greenhalgh, R. 1981. Residual toxicity of fensulfothion in soil and uptake of toxic residues by rutabagas and carrots during wet and dry growing sessions. J. Econ. Entomol. 74:319-329.

Ross, G. J.; Ivarson, K. C. 1981. The occurrence of basic ferric sulfates in some Canadian soils. Can. J. Soil Sci. 61:99-107.

Schnitzer, M.; Hindle, D. A. 1981. Effects of different methods of acid hydrolysis on the nitrogen distribution in two soils. Plant Soil 60:237-243.

Schnitzer, M.; Kerndorff, H. 1981. Reactions of fulvic acid with metal ions. J. Water Air Soil Pollut. 15:97-108.

Schnitzer, M.; Lowe, L. E.; Dormaar, J. F.; Martel, Y. 1981. A procedure for the characterization of soil organic matter. Can. J. Soil Sci. 61:517-519.

Siminovitch, D. 1981. Common and disparate elements in the processes of adaptation of herbaceous and woody plants to freezing—A perspective. Cryobiology 18:166-185.

Singh, J. 1981. Isolation and freezing tolerance of mesophyll cells from cold hardened and non-hardened winter rye. Plant Physiol. 67:906-909.

Singh, J.; Andrews, C. J. 1981. Comparisons of ultrastructural changes during extracellular freezing at −10°C and ice encasement at −1°C in winter wheat crowns by the method of freeze fixation. Cryo-Letters 2:117-124.

Singh, S. S. 1981. Uptake of cadmium by lettuce (*Lactuca sativa*) as influenced by its addition to a soil as inorganic forms or in sewage sludge. Can. J. Soil Sci. 61:19-28.

Sinha, R. C. 1981. Vertical transmission of plant pathogens. Pages 109-121 *in* J. J. McKelvey, Jr., B. F. Eldridge, and J. Maramorosch, eds. Vectors of disease agents: Interactions with plants, animals and man. Praeger Publishers, New York, N.Y.

Sirois, J. C.; Peterson, E. A.; Miller, R. W. 1981. Potential effects of Thiram on *R. meliloti*–Medicago symbiotic association. J. Environ. Sci. Health B 16:293-307.

Stevenson, I. L. 1981. Timing and nature of seed infection of barley by *Cochliobolus sativus*. Can. J. Plant Pathol. 3:76-85.

Stevenson, I. L.; Voisey, P. W.; Hamilton, R. M. G. 1981. Scanning electron microscopy of fractures in eggshells subjected to the puncture test. Poultry Sci. 60:89-97.

Underdown, A. W.; Langford, C. H.; Gamble, D. S. 1981. Light scattering of a polydisperse fulvic acid. Anal. Chem. 53:2139-2140.

Underdown, A. W.; Langford, C. H.; Gamble, D. S. 1981. The fluorescence and visible absorbance of Cu(II) and Mn(II) complexes of fulvic acid: The effect of metal ion loading. Can. J. Chem. 61:469-474.

Wang, C.; Kodama, H.; Miles, N. M. 1981. Effect of various pretreatments on X-ray diffraction patterns of clay fractions of podzolic B horizons. Can. J. Soil Sci. 61:311-316.

Wang, C.; Ross, G. J.; Rees, H. W. 1981. Characteristics of residual colluvial soils developed on granite and of the associated Pre-Wisconsin land forms in north-central New Brunswick. Can. J. Earth Sci. 18:487-494.

Watson, R.; Rowsome, W.; Isoa, J.; Visentin, L. P. 1981. Identification and characterization of Col plasmids from classical Colicin E-producing strains. J. Bacteriol. 147:569-577.

Young, J. C. 1981. Variability in the content and composition of alkaloids found in Canadian ergot. I. Rye. J. Environ. Sci. Health B 16:83-111.

Young, J. C. 1981. Variability in the content and composition of alkaloids found in Canadian ergot. II. Wheat. J. Environ. Sci. Health B 16:381-393.

Miscellaneous

Coote, D. R.; Siminovitch, D.; Singh, S. S.; Chang, C. 1981. The significance of acid rain to agriculture in Eastern Canada. Agric. Can. Res. Br. Publ. 26 pp.

Ivarson, K. C.; Ross, G. J. 1981. Microbial formation of acid sulfate soils. Can. Agric. 26:26-27.

Miller, R. W.; Sirois, J. C. 1981. Calcium effects on bacteroid cell membrane physical properties and metabolic activity. Page 445 *in* Gibson, A. H.; Newton, W. E., eds. Current perspective in nitrogen fixation. Proc. 4th Int. Symp., Canberra, Australia. Australian Academy of Science.

Morita, H. 1981. Perspectives on carbohydrates as chemotaxonomic acids for peats. Proc. Int. Peat Congr. 6:633-637.

Ross, G. J. 1981. Book review: The chemistry of soil constituents. Greenland, D. J.; Hayes, M. H. B., eds. Earth Sci. Rev. 16:379-380.

Schnitzer, M. 1981. Reactions of humic substances with metals and minerals in soils. Pages 229-234 *in* Coll. Int. de C.N.R.S. No. 303 "Migration organo-minérales dans les sols tempérés". Nancy, France.

Schnitzer, M. 1981. The chemistry of humic substances. Chimia 35:293.

Engineering and Statistical Research Institute

Ottawa, Ontario

PROFESSIONAL STAFF

P. W. Voisey, F.I., Mech.E	Director
K. B. Mitchell	Administration

Energy

P. Van Die, B.Sc. (Eng.), M.Sc.	Head of Section; Energy
R. D. Hayes, B.Sc., M.Sc.	Biomass and food
D. LeBlanc, B.Sc. (Eng.)	Processing, distributing, retailing
M. Levesque, B.Sc. (Eng.)	Conservation—buildings
H. A. Jackson, B.Sc. (Eng.), M.Sc.	Greenhouses and solar
D. Marshall, B.Sc. (Eng.)	Biomass and conservation—mechanization

Food Engineering

G. E. Timbers, B.S.A., M.S.A., Ph.D.	Head of Section; Food-process engineering
D. McGinnis, B.Ap.Sc. (Eng.), M.Sc.	Food-process engineering

Research Service

E. J. Brach, D.E.E., Dip.Mil. Electronics	Head of Section; Electronics
D. J. Buckley, B.E., M.Sc.	Electronics

Structures and Mechanization

M. Feldman, B.E., M.Sc.	Head of Section; Mechanization
K. W. Lievers, B.Sc. (Agr.), M.Sc.	Systems analysis
D. Massé, B.Sc.	Canada Plan Service design engineer
G. F. Montgomery, B.Sc. (Agr.)	Mechanization

J. A. Munroe, B.S.A., M.Sc., Ph.D.	Structures
P. A. Phillips, B.Sc. (Agr.), M.Sc., Ph.D.	Animal environment
W. S. Reid, B.Sc. (Agr.), M.Sc.	Mechanization
J. E. Turnbull, B.S.A., M.S.A.	Director of Canada Plan Service; Farm structures

Statistical Research

G. P. Poushinsky, B.Sc., M.Sc.	Head of Section; Statistics
M. R. Binns, M.A., Dip.Math.Stat.	Statistics
G. Butler, B.Math., M.Math.	Statistics
P. Y. Jui, B.Sc., M.Sc., Ph.D.	Statistics
L. P. Lefkovitch, B.Sc.	Statistics
C. S. Lin, B.Sc., M.Sc., Ph.D.	Statistics
P. M. Morse, M.A.	Statistics
B. K. Thompson, B.Sc., M.Math., Ph.D.	Statistics
C. J. Williams, B.S.A., M.Sc., Ph.D.	Statistics
M. S. Wolynetz, B.Math., M.Math., Ph.D.	Statistics
W. Watt, B.A.	Head of Systems and programming
I. Hall, Cert.Info.Proc.	Systems and programming
K. Heng, B.Sc., M.App.Sc.	Systems and programming
J. D. Hobbs, B.Sc.	Systems and programming

Technical Services

J. G. Caron	Head of Section

VISITING SCIENTISTS

C. G. E. Downing, B.E., M.Sc., D.Sc., A.S.A.E., F.E.I.C., F.C.S.A.E., F.A.I.C. Retired April 1977	Former Director, Engineering Research Service
F. R. Hore, B.S.A., M.S. Retired December 1979	Former Head of Section, Water resources

INTRODUCTION

In 1981 the Institute continued to provide a diversity of services in both engineering and biometrics. Some 217 projects were ongoing inhouse, of which 59 were completed and 63 initiated. The outcome is shown in the reports published. Contracting out of research and development (R & D) continued to be a major effort involving 55 projects valued at $3 million, representing (on a fiscal basis) 50% of the total R & D effort of the Institute.

The major change continued to be the reallocation of resources to energy R & D. Contract programs were reorganized to better focus on energy work. The energy component was separated from the agricultural engineering research and development (AERD) program and management of the AERD program (structures and mechanization) was transferred to the Western Region Headquarters at Saskatoon. A new National program for energy research and development in agriculture and food (ERDAF) was organized and implemented to manage the increasing R & D contracting funds available from the National energy program. Some 160 projects valued at $14 million are at various stages of implementation.

Further information is available upon request from the Engineering and Statistical Research Institute, Research Branch, Agriculture Canada, Ottawa, Ont. K1A 0C6.

Peter W. Voisey
Director

ENERGY

Projects are under way to develop a tractor performance meter and a data acquisition system to analyze tractor and meter performance under field conditions.

A farm-scale swine-manure digester was redesigned, incorporating safety and improved manure-handling features. It has been instrumented to provide operational data under farm conditions. A new, advanced methane digester using fixed-film techniques was developed for pilot-scale work to assess a total waste-management system in animal production.

A 50-m length of drainage pipe was buried and instrumented to assess the potential of the ground to supply and absorb heat for agricultural ventilation applications.

Basic design characteristics of eutectic salts packaged in commercial tray units were determined for incorporation in a livestock ventilation heat exchanger and to determine their potential to store solar energy.

Several preliminary studies on novel methods of alcohol and water separation were undertaken, and a still was constructed to study separation by distillation.

Exploratory field-cropping trials of Jerusalem artichoke and New Zealand fodder beets as energy crops were conducted.

An air washer capable of operating near the freezing point of water was designed and constructed to reduce energy consumption in vegetable and fruit storages.

Support material was prepared to enable the Department to participate in the funding allocated to energy R & D through the National energy program. The terms of reference for the Departmental R & D energy program were established. A new component, new liquid fuels, was established to emphasize advanced concept fermentors, alternative methods of hydrolysis, conversion organisms, a total systems approach, utilization of by-products, partial farm processing, and evaluation and testing of agriculturally derived fuels as well as alternative fuels such as propane.

A request for contract proposals was prepared and 170 proposals valued at $16.4 million were evaluated. Scientific authority was provided for 35 contracts. In support of contracted research, instrumentation and technical support was provided at various contract-site locations.

A 1-wk energy workshop was organized.

A new service called the Canada Farm Energy Service has been planned. It will operate in a manner similar to the Canada Plan Service, coordinating provincial and university inputs to produce energy information for the Canadian agricultural industry.

FOOD ENGINEERING

This program concentrates on process and equipment development and on the study of fundamental properties of foodstuffs. Feeding trials with material from the new γ-globulin processing system have been successful and a patent has been filed. Patents were also filed on the Agriculture Canada/ABCO blancher. The blancher won a 1981 food-processing award; it was judged to be a major contribution to more efficient and effective operations in the food-processing industry. The blancher system is now being marketed internationally. Studies on microwave processing have continued in cooperation with the National Research Council of Canada for the processing of mustard and rapeseed. Process development is continuing with work on liquid cyclones and engineering studies on retort-pouch processing.

An instrumented vacuum laboratory ribbon blender was completed for use in meat research. Data on the thermal conductivity of meat emulsions were gathered.

The food-texture measurement area is making increasing contributions through technology transfer to industry. Assistance to the industry in technique development has aided several Canadian food companies. A contribution was made to assist in setting up a food-texture laboratory at the University of Campinas in Brazil.

Ongoing work includes studying computer control of retorts, updating moisture-equilibrium data for canola, measuring protein gel strength without distrupting the gel, and developing techniques and procedures for quality evaluation of chapatis, lentils, and chick-peas.

RESEARCH SERVICE

The design and development of instruments and equipment to support research operations across the Branch continued, and a range of equipment was produced for use in both research and regulatory work of the Department.

Plot equipment included a portable bean-size grader, a rotary drum for conditioning cereal grain, a Timothy bundle head separator, a tobacco seed classifier and cleaner, and a modified pesticide spray room.

Instrumentation developed included an air-bearing wind vane anemometer, a data acquisition system for measuring crops, a sheep digesta sampler, a conversion mechanism to adapt a waring blender mixing assembly for accommodation of scalpel blades, a body and testicular caliper for sheep, an adjustable sample lighting system for Reichart microtones, an image-maker processor, and a portable egg candler. The portable egg candler is now under industrial production as a standard for the Department's egg-grading inspectors.

Scientific developments included an instrument to inhibit auxin (IAA) translocation in various plant tissues and a technique to measure winterhardiness or drought stress of grain crops using bioluminescence.

An improved spectral radiometer for field spectroscopy was developed.

STRUCTURES AND MECHANIZATION

Structures

The Canada Plan Service (CPS) completed 22 plans, 17 revisions, 30 leaflets, 4 quick-release plans, 2 bulletins, and 1 revised bulletin. Metrication is now 71% complete.

Development of concrete sandwich walls and pen partitions continued, and a third building was constructed resolving most of the problems that existed with the first two prototypes. Tests with a new joint design for steel diaphragm ceilings verified design calculations providing a design that is a much easier system to build, benefiting the whole industry. The design has been incorporated into five new CPS plans.

Observations were completed on floating covers for liquid manure tanks, confirming the practical and economical odor supression available compared with a covered tank. Work continued on detection and purging of hazardous gases from silos. An improved system was developed to utilize the forage blower to purge the silo.

Preliminary tests on a barn heat exchanger showed promise for the design and led to an energy R & D contract proposal and a company commitment to proceed toward production.

A French version of the *Metric Guide* was produced. The publication *Insulation of Farm Buildings* was completed and will be useful for agricultural advisers when building with metric components becomes more popular.

Mechanization

Evaluation of four vegetable planters was completed; useful extension information was provided on three of the units and advice was provided to the distributor and manufacturer on required improvements for the fourth. A commercial cucumber harvester was modified, with potential for harvesting smaller cucumbers during field tests, and development is progressing on a multi-pick design.

One contractor has achieved a satisfactory functional design for a large round bale processor, and another has identified characteristics and suggested improvements for various silage distributors for vertical silos.

The sensitivity analysis of Eastern Canadian dairy production systems was completed, providing a computer model for use by experienced operators. A telephone survey on systems and modeling activities to obtain data for a report on the Canadian situation was completed.

Work completed under contract on aeration and storage of grain corn upgraded information on crop conditions and aeration for storage of corn in silos. A belt dryer was evaluated with alfalfa.

For tobacco mechanization, two racks and cutter were built for cooperating establishments. A liquid manure injector for sod was tested. A work-planning meeting on application of aviation in agriculture was held.

The *Agricultural Materials Handling Manual* was completed and published.

Two IRAP (industry research assistance program) projects were completed, after successfully supporting combine research and an advanced cutting-knife design.

STATISTICS

Statistical support was provided in many areas of agricultural research. For the tobacco research program, collaboration took place for studies on yield, field conditions, chemical properties, manufacturing processes, health aspects, and sampling methods for both cigarette and cigar tobacco. Methods of evaluating crop loss in soybeans and corn were investigated. Support was given to corn, barley, potato, and wheat breeding programs and to the rapeseed and mycotoxin programs. Collaboration on the sensory evaluation of veal, swine, beef, turkey, chicken, lamb, and dairy products occurred. Studies on the reproductive performance and growth of sheep, swine, poultry, and cattle and on trace minerals in sheep and cattle were carried out. Bioassay studies involving herbicides and insecticides were supported.

Investigations were carried out on cluster analysis methodology, the implications of using covariance analysis, survival data analysis methodology, corrections for environmental conditions, and experimental design.

An interactive computer software package (AGSTAT) to assist researchers in the examination and analysis of their data was developed for the AgriNet system. Specifications have been developed for facilitating the analysis of unbalanced data and bioassay-type data.

TECHNICAL SERVICES

The Institute workshops continued to provide a service for the fabrication and maintenance of scientific equipment. During the year, 2150 work orders were completed.

PUBLICATIONS

Research

Andrews, R. I.; Thompson, B. K.; Trenholm, H. L. 1981. A national survey of mycotoxins in Canada. J. Am. Oil Chem. Soc. 58:589A-991A.

Arnold, N.; Chong, C.; Binns, M. R. 1981. A comparative study of the mineral nutrients in grey and non-grey flue-cured tobacco. Can. J. Plant Sci. 61:703-710.

Bolton, E. F.; Dirks, V. A.; Hore, F. R. 1980. Corn, soybean and wheat yields on Brookston clay drained by plastic tubing installed by two methods at seven spacings and two depths. Can. Agric. Eng. 22:145-148.

Brach, E. J.; Crete, R. 1981. Rapid method of estimating numbers of spores of *Plasmodiophora brassicae* in inoculum suspension. Can. J. Plant Pathol. 3:106-109.

Brach, E. J.; Desjardins, R. L.; St-Amour, G. T. 1981. Open path CO analyzer. J. Phys. E. Sci. Instrum. 14:1415-1419.

Buckley, D. J.; St-Amour, G. R.; Fairful, R. W. 1981. An improved electronic gauge for measuring egg albumen height. Poult. Sci. 60:777-780.

Chiykowski, L. N.; Wolynetz, M. S. 1981. Susceptibility of oat cultivars to aster yellows isolates from Eastern Canada. Can. J. Plant Pathol. 3:53-57.

Culley, J. L. B.; Phillips, P. A.; Hore, F. R.; Patni, N. K. 1981. Soil chemical properties and removal of nutrients by corn resulting from different rates and timing of cattle liquid manure applications. Can. J. Soil Sci. 61:35-46.

Depauw, R. M.; Faris, D. G.; Williams, C. J. 1981. Genotype–environment interaction of yield in cereal crops in northwestern Canada. Can. J. Plant Sci. 61:255-263.

Duvnjak, Z.; Kosaric, N.; Hayes, R. D. 1981. Kinetics of ethanol production from Jerusalem artichoke juice with some *Kluyveromyces* species. Biotech. Lett. 3(10):589-594.

Friend, D. W.; Wolynetz, M. S. 1981. Self selection of salt by gilts during pregnancy and lactation. Can. J. Anim. Sci. 61:429-438.

Grunder, A. A.; Thompson, B. K.; Hollands, K. G.; Hamilton, R. M. G. 1981. Shell strength changes by three hours after oviposition and influence of polyurethane foam covered cage floors. Poult. Sci. 60:1140-1144.

Hackett, A. J.; Robertson, H. A.; Wolynetz, M. S. 1981. Effects of prostaglandin F and pregnant mares' serum gonadotropin (PMSG) on the reproductive performance of fluorogestone acetate-PMSG-treated ewes. J. Anim. Sci. 53:154-159.

Hackett, A. J.; Wolynetz, M. S. 1981. Comparison of natural mating and artificial insemination on reproductive performance of three strains of sheep housed in total confinement. Can. J. Anim. Sci. 61:907-912.

Hamilton, R. M. G.; Grunder, A. H.; Thompson, B. K.; Hollands, K. G. 1981. Relationship between blood ionized calcium levels and shell strength of eggs laid by white leghorn hens. Poult. Sci. 60:2380-2384.

Hamilton, R. M. G.; Thompson, B. K. 1981. The effects of storage duration on nondestructive deformation, quasi-static compression strength, impact fracture strength and specific gravity of eggs from white leghorn hens. Poult. Sci. 60:517-522.

Hamilton, R. M. G.; Thompson, B. K. 1981. Effects of the sequence of measuring nondestructive deformation and specific gravity on the quasi-static compression and impact strength of eggs from white leghorn hens. Poult. Sci. 60:1798-1801.

Harcourt, D. G.; Binns, M. R. 1981. Sampling techniques for the soil-borne stages of *Agromyza frontella* (Rond.) (Diptera: Agromyzidae). Great Lakes Entomol. 13:159-164.

Hergert, G. B.; Voldeng, H. D. 1981. High capacity soybean plot seeder—Notes. Can. J. Plant Sci. 61:1013-1016.

Hergert, G. B.; Walker, E. K. 1981. Equipment for whole-plant harvest of flue-cured tobacco. Can. Agric. Eng. 23:5-9.

Hidiroglou, M.; Ho, S. K.; Thompson, B. K.; Proulx, J. G. 1981. Hypomagnesaemia in beef cows wintered in Ontario. Can. J. Comp. Med. 45:124-129.

Hidiroglou, M.; Thompson, B. K. 1980. Serum alkaline phosphatase activity in beef cattle. Ann. Rech. Vet. 11:381-389.

Kramer, J. K. G.; Farnworth, E. R.; Thompson, B. K.; Corner, A. H. 1981. The effect of dietary fatty acids on the incidence of cardiac lesions and changes in the cardiac phospholipids in male rats. *In* Holman, R. T., ed. Progress in lipid research 20: Essential fatty acids and prostaglandins. Pergamon Press, Oxford.

Laseau, M. J.; Rouselle, G. L.; Price, K. 1981. Red colour evaluation of 'Mackintosh' apples with the 'Techwest' colour meter. Can. J. Plant Sci. 61:757-759.

Morse, P. M.; Thompson, B. K. 1981. Presentation of experimental results. Can. J. Plant Sci. 61:799-802.

Munroe, J. A.; Wolynetz, M. S.; Turnbull, J. E.; Darisse, J. P. F. 1981. Cold weather conditions in a free-stall barn fitted with a porous ceiling. Can. Agric. Eng. 23:17-21.

Nagai, J.; Hunsaker, W. G.; Wolynetz, M. S. 1981. A system for recording maternal behaviour of lactating mice. Zwierzeta Lab. 18:53-57.

Phillips, P. A.; Hore, F. R.; Patni, N. K.; Culley, J. L. B. 1981. Pollution potential and corn yields from selected rates and timing of liquid manure applications. Trans. Am. Soc. Agric. Eng. 24:139-144.

Stevenson, I. L.; Voisey, P. W.; Hamilton, R. M. G. 1981. Scanning electron miscroscopy of fractures in eggshells subjected to the puncture test. Poult. Sci. 60:89-97.

Thompson, B. K.; Hamilton, R. M. G.; Voisey, P. W. 1981. Relationships among various egg traits relating to shell strength among and within five avian species. Poult. Sci. 60:2388-2394.

Turnbull, J. E. 1980. Housing and environment for dairy calves. Can. Vet. J. 21:85-90.

Turnbull, J. E.; Lefkovitch, L.; Lowe, D. 1981. Multi-laminated nailed truss connections. Can. Agric. Eng. 23:113-119.

Voisey, P. W.; Kloek, M. 1981. Effect of cell size on the performance of the shear-compression texture test cell. J. Texture Stud. 12:133-139.

Voisey, P. W.; Kloek, M.; Mohr, W. P. 1980. A method for recording the amplitude of force fluctuations during texture tests—Research note. J. Texture Stud. 11:395-400.

Walker, E. K.; Fagan, W. E. 1981. An improved lamina sampler for cured tobacco. J. Tob. Sci. 25:13-14.

Miscellaneous

Baum, B. R.; Thompson, B. K.; Bailey, L. G.; Brown, M. 1981. Barley register (A first report). Research Branch, Agriculture Canada.

Brach, E. J.; Mack, A. R.; St-Amour, G. R. 1981. Mobile field laboratory instrumentation to measure spectral characteristics of agricultural crops. Engineering and Statistical Research Institute, Agriculture Canada. Rep. No. 6842 626.

Buckley, D. J. 1981. Recommendations for interfacing scientific instruments to computers or computer-compatible recorders. Engineering and Statistical Research Institute, Agriculture Canada. Rep. No. 7804 1329.

Desjardins, R. L.; Alvo, P.; Brach, E. J.; Schuepp, P. H. 1981. Carbon dioxide exchange using aircraft-mounted sensors. Engineering and Statistical Research Institute, Agriculture Canada. Rep. No. 7402 1256.

Desjardins, R. L.; Alvo, P.; Brach, E. J.; Schuepp, P. H. 1981. Carbon dioxide flux measurement from aircraft-mounted sensors. Engineering and Statistical Research Institute, Agriculture Canada. Rep. No. 7402 1270.

Fagan, W. E.; Buckingham, J. E. 1981. A 50-hole punch for forage sample bag aeration. Forage Notes 25(2) (Fall).

Hamilton, R. M. G.; Grunder, A. A.; Thompson, B. K.; Hollands, K. G. 1981. Changes in egg shell strength up to 21 days after oviposition. Proc. Spelderhold Jubilee Symp., Apeldoorn, Holland (May). pp. 104-110.

Hayes, R. D. 1981. Agriculture Canada's liquid fuels R&D program. Proc. 2nd Natl. Power Alcohol Conf., Winnipeg, Man. Engineering and Statistical Research Institute, Agriculture Canada. Rep. No. 1349 (October).

Hayes, R. D. 1981. Farm-scale production and use of fuel alcohol/Production et utilisation d'alcool combustible a la ferme. Canadex 760 (February).

Hayes, R. D. 1981. Farm scale alcohol—Fuel for thought. Can. Agric. 26(3):14-16.

Hayes, R. D. 1981. Energy crops—What little we know/Le peu que nous savons sur les cultures energetiques. Engineering and Statistical Research Institute, Agriculture Canada. Rep. No. 8123 1281.

Hergert, G. B. 1981. Burley production methods ready for a change. Engineering and Statistical Research Institute, Agriculture Canada. Rep. No. 1271.

Hollands, K. G.; Grunder, A. A.; Williams, C. J.; Gavora, J. S.; Chambers, J. R. 1981. Degenerative myopathy in meat type poultry: Its effect on production traits in chickens and its identification in live turkeys. Proc. Spelderhold Jubilee Symp., Apeldoorn, Holland (May). pp. 337-344.

Jackson, H. A. 1981. Energy conservation in greenhouses/Conservation d'energie dans les serres. Engineering and Statistical Research Institute, Agriculture Canada. Rep. No. 1277.

Kloek, M.; Mohr, W. P. 1981. Supplemental data for the evaluation of tomato juice graininess using the back extrusion method. Engineering and Statistical Research Institute, Agriculture Canada. Rep. No. 1316.

Kloek, M.; Pearce, D. 1981. Objective texture measurements of raw blanched and canned bean sprouts. Engineering and Statistical Research Institute, Agriculture Canada. Rep. No. 8049 1278.

Levesque, M. P. 1981. Bilan energetique de l'enterprise agricole. Engineering and Statistical Research Institute, Agriculture Canada. Rep. No. 1302.

Liptay, A.; Hergert, G. B.; Loughton, A. 1981. Baby carrot production in Ontario. Ontario Ministry of Agriculture and Food. Bulletin No. 81-078 (July).

Marshall, D. 1981. Saving energy in the dairy barn—Use of the bulk tank as a heat pump/Utilisation du reservoir en vrac comme pombe a chaleur. Canadex 720.

Marshall, D. 1981. The potential for use of the wind as a farm energy source. Engineering and Statistical Research Institute, Agriculture Canada. Rep. No. 1321.

Marshall, D. 1981. Energy conservation in the milking parlour. Engineering and Statistical Research Institute, Agriculture Canada. Rep. No. 1354.

Montgomery, G. F.; Morrison, B. A.; Thuns, A. 1981. Summary of projects and publications—April 1981/Sommaire des projets et des publications—Avril 1981. Engineering and Statistical Research Institute, Agriculture Canada. Rep. No. 8100 I289.

Morrison, B. A.; Thuns, A. 1981. Energy reports published by Engineering and Statistical Research Institute from 1973 to February 1981. Engineering and Statistical Research Institute, Agriculture Canada. Rep. No. I291.

Morrison, B. A.; Thuns, A. 1981. Engineering and Statistical Research Institute file classification system, used by Support Services/Systeme de classification des dossier, de l'Institute de recherche technique et statistique utilise par les services de soutient. Engineering and Statistical Research Institute, Agriculture Canada. Rep. No. I358.

Munroe, J. A.; Milne, R. J.; Hodgkinson, D.; Barber, E. 1981. Tie-stall dairy cattle housing. Agric. Can. Publ. 1714.

Munroe, J. A.; Milne, R. J.; Hodgkinson, D.; Barber, E. 1981. Free-stall dairy cattle housing. Agric. Can. Publ. No. 1715.

Reid, W. S.; Desjardins, R. L.; Buckley, D. J.; Fagan, W. E. 1981. Air bearings in a windvane propeller anemometer. Engineering and Statistical Research Institute, Agriculture Canada. Rep. No. I290.

Reid, W. S.; Willis, T. G.; Fagan, W. E. 1981. Problems of selection of equipment for developing countries exemplified by a bulk milk cooler installation for East Africa. Engineering and Statistical Research Institute, Agriculture Canada. Rep. No. I295.

Thuns, A. 1981 Contract references 1974–1980. Engineering and Statistical Research Institute, Agriculture Canada. Rep. No. I359.

Timbers, G. E. 1981. Measurement of white bean color. Engineering and Statistical Research Institute, Agriculture Canada. Rep. No. I324.

Timbers, G. E.; Marshall, D. 1981. Biogas as a farm energy source/Le methane comme source d'energie agricole. Engineering and Statistical Research Institute, Agriculture Canada. Rep. No. I297.

Turnbull, J. E.; Bird, N. A. 1981. Confinement swine housing. Agric. Can. Publ. 1451.

Van Die, P. 1981. Energy and the Canadian agriculture and food industry. Engineering and Statistical Research Institute, Agriculture Canada. Rep. No. I266.

Van Die, P. 1981. Solar heating of greenhouses/Chauffage solaire des serres. Canadex 731 (February).

Voisey, P. W. 1981. Manure management bibliography. Engineering and Statistical Research Institute, Agriculture Canada. Rep. No. I293.

Food Research Institute

Ottawa, Ontario

PROFESSIONAL STAFF

J. Holme, B.A., M.A., Ph.D.	Director
B. Maguire	Administrative Officer

Processing Technology and Food Quality

D. Froehlich, B.Sc., M.Sc.	Sensory evaluation
M. Kalab, M.Sc., Ph.D.	Electron microscopy
C. Y. Ma, B.Sc., M.Sc., Ph.D.	Protein functionality
R. C. McKellar, B.Sc., M.Sc., Ph.D.	Dairy product microbiology
B. D. Oomah, M.Sc., Ph.D.	Cereal processing
D. Paton, B.Sc., Ph.D.	Program Leader; Processing technology
R. Sinha, B.Sc., M.S., Ph.D.	Dairy product microbiology
I. Siddiqui, B.Sc., M.Sc., Ph.D., D.Sc., F.R.I.C.	Carbohydrates
D. F. Wood, B.Sc., M.Sc., Ph.D.	Meat processing
C. G. Zarkadas, B.Sc., M.Sc., Ph.D.	Meat proteins

New Product and Ingredient Development

P. J. Wood, B.Sc., Ph.D.	Program Leader; Carbohydrates
F. W. Collins, B.Sc., Ph.D.	Phenolics chemistry
D. B. Emmons, B.S.A., M.S., Ph.D.	Dairy products
V. R. Harwalkar, B.Sc., M.Sc., Ph.D.	Protein chemistry
J. D. Jones, B.Sc., M.Sc., Ph.D., F.R.I.C.	Oilseeds fractionation
H. W. Modler, B.S.A., M.S., Ph.D.	Dairy products
G. Paquette, B.Sc.	Dairy products
M. Sahasrabudhe, B.Sc., M.Sc., Ph.D.	Lipids
J. Weisz, B.Sc.	Carbohydrates

Food Safety and Nutrition

W. J. Mullin, L.R.I.C., Ph.D.	Program Leader; Analytical methodology

R. A. Holley, B.Sc., M.Sc., Ph.D.	Meat microbiology
A. C. Nunes, B.Sc.	Nutrient analysis
A. Paquet, B.Sc., Ph.D.	Amino acid chemistry
F. Russell, B.Sc., M.Sc.	Nutrient analysis

Departures

E. Larmond Promoted to new position, 30 January 1981	Assistant Director; Program Leader, Sensory evaluation
A. C. Nunes Retired 31 December 1981	Nutrient analysis
J. Schafer Promoted to new position	Acting Administrative Officer

INTRODUCTION

The programs of the Food Research Institute (FRI) continued to progress well in 1981, particularly in areas of collaboration with industry and development of new technology for transfer to the private sector. Areas of rapeseed fractionation, cereal fractionation, restructured meat preparation, whey utilization, and involvement of microorganisms in milk gelation received concentrated attention.

The food safety and nutrition program was further consolidated and expanded, with a collaborative program in lipid biochemistry and nutrition being initiated with the Animal Research Centre. Dr. John Mullin was appointed Program Leader of the safety and nutrition program upon return from a transfer of work at Norwich, U.K. Dr. Alenka Paquet commenced a transfer of work at the University of Ottawa, where she is to conduct research on new methods of peptide synthesis.

The Institute was saddened by the untimely death of Mr. Andrew Koenig, a member of the technical staff, who had served the research activities of FRI well over many years.

The Institute welcomed Mrs. Brenda Maguire as its new Administrative Officer and bid adieu to Elizabeth Larmond and Joanne Schafer, who accepted positions in Branch Administration, and Alex Nunes who retired from the Public Service.

Highlights of the year's results are described in this report. Inquiries for more information should be directed to the Food Research Institute, Research Branch, Agriculture Canada, Ottawa, Ont. K1A 0C6.

John Holme
Director

PROCESSING TECHNOLOGY AND FOOD QUALITY

Extrusion cooking

A project is in progress which seeks to identify relationships between final-product functionality and the extent of alteration of starch structure as may be influenced by changes in extrusion conditions. Extruding wheat starch over a range of temperature, moisture, and screw speeds and examining the internal barrel contents have permitted very definite transition melt zones to be identified, and the length of each has been measured. Gel permeation chromatography of final extruded product indicates an apparent variable reduction in the amylopectin component of the starch as a function of extruder conditions. The extent of this reduction appears in turn to be a function of the position and length of the transition melt zone. Work is in progress using specific starch-degrading enzymes to establish whether these results are simply due to a quantitative reduction in the amount of amylopectin or to new starch species being produced, since final-product viscosity seems difficult to relate to the other measured parameters.

The Ottawa starch viscometer has provided valuable information on the degree of thermal processing of certain extruded cereal products as a result of several cooperative ad hoc projects with organizations outside of government. This information has supported the purchase or purposed purchase of this instrument by several industrial and governmental research centers in North America and overseas.

Meat products

In a contract project with the University of Alberta, the feasibility of recovering food-grade animal protein from currently discarded residues from mechanical deboning operations was examined. Proteins were extracted with alkali, precipitated by acid, and texturized by freezing. The product was microbiologically sound and was free from any lysinoalanine when produced under normal processing conditions. The freeze-textured protein was found to possess sufficient functionality to be used at a 20% replacement level in a luncheon meat product with no loss of sensory acceptability.

In cooperation with industry, a project was conducted to evaluate the effects of storage time and temperature on the functionality of

frozen meat in comminuted meat products. A loss in product yield and changes in product texture have been experienced with time, particularly when meat is stored frozen at −10°C. Most major processors use least-cost formulation for comminuted meat products, and much of the data on binding has been collected using fresh meat. With increasing usage of frozen ingredients, the foregoing data are helping to explain textural variations in the finished products.

Methodology for measurement of τ-methylhistidine, the isomeric 5-hydroxylysines, and desmosines and isodesmosines as indicators of meat protein present in admixture with plant proteins has been finalized and reported. The feasibility of the procedure is under investigation with industry to ascertain its general applicability for control of mixed-protein products.

Sensory evaluation

Sensory analysis of foods continues to be used extensively in support of projects both inside and outside of government and includes assessment of commodities such as milk, cheeses, butter, pork, lamb, poultry, eggs, veal, and beef.

The Sensory Unit once again has played a key role in providing training courses and workshops for industrial, governmental, and university personnel.

An industry–government committee has been established to evaluate the suitability of various wrapping materials in protecting butter from the effects of fluorescent lighting in retail outlets. A survey of handling practices in stores revealed lighting loads of up to 5400 lx. Eleven wrappers varying in their light absorption characteristics were evaluated at various light intensities for varying periods of time. Peroxides were measured on the surface and in the interior of the butter, and a trained sensory panel was used to measure the level of parameters studied. Aluminum foil performed best, with no detectable oxidation, whereas two metallized parchments showed slight incidences. All other wrappers were considered unsatisfactory. This work is being continued and liaison maintained with the appropriate agencies in an attempt to develop new standards in Canada for butter wrappers.

The effect of restricting the feed regimen of once-bred gilts in early gestation upon the carcass quality was examined from the standpoint of producing marketable bred gilts of acceptable weight. The normal practice of gilt breeding tends to lead to weight gains due to excessive fat deposits. The carcasses of gilts that had been zero-weaned or suckled for a 21-day period, followed by either immediate slaughter or rebreeding, were evaluated by a trained sensory panel for flavor, tenderness, and juiciness. Using a descriptive analysis with scaling method, no significant difference was found for the treatments in both loin and round roasts.

A project on egg-quality characteristics has been partially completed in response to consumer concerns over aroma and flavor of eggs purchased at the retail level. Using a trained panel, egg aroma and flavor have been described and significant differences were found for these characteristics in 1-day-old and 1-wk-old eggs. In the second phase of this project, the effect of variables such as egg washing, storage time, and storage temperature on flavor and aroma perception will be evaluated.

Milk quality

The effect of storage time on the proteolysis, viscosity, and flavor profile of ultra-high temperature (UHT) treated milk has been examined. A good correlation was obtained between the extent of proteolysis and the development of off-flavor in milk sterilized both by the direct and indirect methods. Proteolysis, coagulation, and off-flavor development appeared more extensive in directly sterilized milk.

Proteinase production by psychotrophic bacteria in refrigerated milk is a recognized problem to the dairy industry. Studies have been completed to assess the nutritive requirement to sustain synthesis of proteinases by these organisms. Increasing the concentration of skim milk in the media also increased the production of proteinase. Even at 5°C, proteinase activity was 55% of that found at 20°C. Closer examination of skim milk by a combination of high-speed centrifugation and gel-filtration chromatography revealed a low molecular weight fraction (<5000 daltons), which actively stimulated proteinase production, whereas higher molecular weight fractions were found to be inactive.

Protein functionality

Further experimentation was conducted to study the effect of chemical modification on protein functionality and physicochemical properties. The emulsifying activity index (*EAI*) was increased in succinylated plant proteins, oat being the most dramatic. Succinylation also improved the emulsion stability index (*ESI*) for oat and fat absorption capacity for canola proteins. Egg albumin was modified with succinic anhydride and water-soluble anhydride to change the net charge on the protein. Heat-induced coagulation was retarded by both modifications, suggesting that thermocoagulation requires a balanced electrostatic attraction between protein molecules. Hydrophobicity measurements and pH-titration data confirm the involvement of hydrophobic and ionic interactions in the gelation process. The soluble fraction of the heat-coagulated protein contained denatured monomers, whereas under conditions where a gel was not formed, high-molecular-weight soluble aggregates were present. Based on these data, a scheme for the thermocoagulation of egg albumin was proposed. $N \rightleftharpoons D \rightarrow A \rightarrow G$ where N and D are native and denatured monomers, A is the soluble aggregate, and G the gel or coagulum.

Microstructure

Methodology has been developed for the detection of buttermilk solids in meat binders; it is based upon the removal of sedimentable solids, e.g. flours and spices, by low-speed centrifugation. The milk solids in suspension are then isolated by ultracentrifugation and examined by electron microscopy (EM). Buttermilk solids can be detected by the presence of fat-globule membrane fragments.

Some of the most important changes occurring in milk during gelation take place at casein micelle surfaces. The established EM techniques of metal shadowing, negative staining, and thin sectioning are unsatisfactory in this case because the casein micelle surfaces are not available to viewing at high magnifications. A new technique has been developed, whereby fixed casein micelles, attached to polylysine-coated freshly chewed mica, are dehydrated in a graded alcohol series. After critical-point drying and rotary coating with platinum carbon, the corpuscular microstructure of the micelle surface is clearly visible, indicating that the globular micelle shape has been preserved.

Significant differences in microstructure, sensory attributes, and instrumental texture have been found for cream cheeses of the traditional and new-formulated types. Differences in fat-globule integrity and protein distribution were clearly evident. The traditional-style cream cheese was rated high in firmness, adhesiveness, and instrumental compressibility, whereas the new formulated cheeses were superior in spreadability. The differences in sensory characteristics were closely related to observed differences in cheese microstructure.

Carbohydrates

Research has continued in order to establish the nature and structure of bound nornicotine alkaloid in a good-quality Canadian tobacco (Delhi 76). Using a combination of hydrolysis, gas–liquid chromatography, mass spectrometry, and ^{13}C-nuclear magnetic resonance, the compound has been established as 1-deoxy-1-[(*S*)-2-(3-pyridyl)-1-pyrrolidinyl]-β-D-fructopyranose.

Fourteen low-molecular-weight carbohydrates from the 80%-ethanol-soluble fraction of Delhi 76 have been characterized either in the crystalline form or as crystalline derivatives or by chromatographic analysis of partial-hydrolysis products. The 80%-ethanol-soluble fraction amounted to 36.5% by weight and was found to contain by weight (percentage) D-ribose, 0.11; D-xylose, 0.19; D-fructose (containing 0.97% D-psicose), 9.61; D-glucose, 3.24; D-sorbitol, 0.02; myo-inositol, 1.04; 1-deoxy-1-[*S*-2-(3-pyridyl)-1-pyrrolidinyl]-β-D-fructopyranose, 0.26; sucrose, 6.24; maltose, 0.34; gentibiose, 0.01; D-glucopyranosyl-myo-inositol, 0.04; erlose, 0.02; and theanderose 0.01.

Malic acid was present to the extent of 11.02% and several unknown components. A major pectic polysaccharide has been isolated from the water-soluble fraction of the same tobacco variety.

FOOD SAFETY AND NUTRITION

Yeast contamination of mustard seed

Elimination of *Nematospora coryli* from microwave-heated *Brassica juncea* seed was accomplished at 87°C in seed containing 6.8% moisture, but at 9.95% moisture no viable yeast could be recovered at 71°C or higher. A further increase in temperature of 14°C was required before a loss in myrosinase activity

was noted in each seed lot. Storage of unheated mustard seed adjusted to >8% moisture at 24 and 37°C led to the death of the yeast within 13 days at 37°C whereas at 24°C between 14 and 64 days were required. Yeast survival in the seed was inversely related to seed moisture. No significant changes in number of microorganisms present were noted during storage of seeds at 4°C. Growth of mold on the seed at moisture levels >10% was noted during storage at 24 and 37%. The cause of yeast death during storage of moisture-amended seed is believed the result of the toxicity of allyl isothiocyanate produced by myrosinase naturally occurring in the seed.

Meat lactic bacteria

Biochemical characteristics of commercial meat starter cultures and bacteria isolated from commercial cured meat products were studied. The predominant organisms in fermented products made without starters were lactobacilli. In some products where the label claimed the use of a specific lactobacillus starter, no viable starter organisms could be found. Gram-negative bacteria and potential pathogens were virtually absent. Research is continuing to identify existing populations and competitive activities of principal organisms affecting population changes.

Poultry hatchery sanitation

In-plant and laboratory evaluations were conducted for a commercial swab-test kit for routine use in maintaining the sanitary condition of the hatchery. The kit was shown to be valuable for use by untrained personnel for collecting data on potential trouble spots within the plant. Data that compare recovery efficacy of hatchery isolates from artificially contaminated surfaces were obtained. The importance of using nonspecific recovery media and of ensuring that cleaned surfaces are properly dried was underlined.

Amino acid derivatives

The work on preparation of amino-protected hydroxyamino acids resulted in the discovery of several new amino-group-protecting agents and in the derivation of new routes of peptide synthesis involving hydroxyamino acids. Unusual side products arising from succinimidyl esters of fatty acids during the acylation of amino acids were isolated and their structures were elucidated. The mechanism of formation of these succinohydroxamic fatty acid anhydrides has been determined.

Nutrient data for Canadian food sources

Vitamin A. Using the method of the Association of Vitamin Chemists (1966), we determined the vitamin A content of 16 varieties of regular and 6 varieties of mini carrots. Data from two growing seasons indicated no consistent intervarietal differences, but the vitamin A content was found to vary widely, ranging from 4000 IU to 10 000 IU.

Vitamin C. The standard titrimetric determination for L-ascorbic acid was modified to improve precision and accuracy, and the modified technique was applied to field-grown regular and mini carrots, cabbage, and spinach, as well as commercially packed fresh spinach.

All field-grown crops showed minor varietal differences in their L-ascorbic acid contents. However, maturity at harvest and postharvest storage appeared to affect the L-ascorbic acid levels in spinach more significantly than variety. Losses of L-ascorbic acid in field-grown spinach after refrigerated storage for 10 days postharvest was as high as 70%. In addition, L-ascorbic acid levels in commercially packed fresh spinach were extremely variable, ranging from 10 to 75 mg/100 g fresh weight.

These data augment the results of previous work conducted to develop a nutrient data base for vitamin C.

Folacin. The first phase of the study of folacin in selected cultivars of fresh spinach, swiss chard, broccoli, and brussels sprouts was completed; the standard *L. casei* microbiological assay was used for all analyses. Results indicated that there were no significant intervarietal differences in the "free" or "total" folacin content. All vegetables contained relatively high amounts of folacin as expected and are major contributors to the required daily intake of the nutrient. The free folacin content of spinach increased two-fold during the 7-day storage period after harvest, whereas the total folacin content remained constant. No significant loss of folacin was observed over a 14-day storage period at 4°C, which is the period normally encountered in commercial production before consumption. Greenhouse-grown crops showed unusually high initial free folacin content, which may have been caused by the absence of pesticide

treatment or the more controlled growing conditions.

Glucosinolate studies. Although no laboratory work was carried out in this area, a major review of glucosinolates in food and feed was completed and another review on the analysis of glucosinolates will be published.

NEW PRODUCT AND INGREDIENT DEVELOPMENT

Oats

Carbohydrates. Studies of the interaction of cereal β-(1 → 4)(1 → 3)-linked D-glucans with Congo Red and CalcoFluor have continued. In cereal cell-wall fractions, only the mixed-linkage β-glucan shows interaction with both dyes. Anionic polysaccharides such as *O*-(carboxymethyl)-pachymen and *O*-(carboxymethyl)-cellulose interact strongly with the dyes in the presence of *M* NaCl; certain polysaccharides that require dilute alkali for solubilization, such as starch and curdlan (a β-(1 → 3)-glucan) only show significant interaction if 0.5 *M* NaCl is included in the 0.05 *M* NaOH used for solution. Starch interacted only with Congo Red (20 nm red shift) and not with CalcoFluor. Congo Red shows a 12- to 13-fold increase in fluorescence intensity in the presence of oat β-glucan, which is three or four times the increase shown by CalcoFluor. However, Congo Red fluorescence is susceptible to interference by starch.

Studies of β-glucanases using gel diffusion techniques and Congo Red staining were continued, and an assay for β-(1 → 3)-glucanase in germinating barley seeds was developed. The gel diffusion technique compared well with viscometric results (correlation 0.96). The principle of this technique has been applied to survey enzyme activities in rumen microorganisms (collaboration, R. M. Teather, Animal Research Centre).

The interaction of Aniline Blue with β-(1 → 3)-glucans has been investigated using fluorescence spectroscopy. The major fluorescence excitation and emission peak shows changes in the presence of a number of different polysaccharides but a peak with an emission λ_{max} of 495 nm was only detectable in the presence of β-(1 → 3)-glucan, when fluorescence intensity increases of up to 55-fold were observed. The evidence indicates that this behavior is the result of a minor component of the crude dye preparation. In a survey of about 30 polysaccharides only β-(1 → 3)-glucans showed this interaction with Aniline Blue. Laminaran was much less effective than the higher-molecular-weight curdlan. The interaction was conformation sensitive, being observed in 0.05–0.2 *M* NaOH but not in 0.5 *M* NaOH. β-(1 → 3)-Glucan has been demonstrated to be present in cereal cell walls (especially barley) using fluorescence microscopy (collaboration, R. G. Fulcher, Ottawa Research Station). Attempts to demonstrate this with crude extracts of barley failed, in part at least, because of the presence of contaminating fluorescent components in the extracts; the presence of β-(1 → 3)-glucan in extracts from the hyphal cell walls of *Fusarium sulphureum* (a fungal pathogen of potatoes) could, however, be demonstrated.

The effect of shear rate and solvent on viscosity of oat gum preparations was studied. The high-viscosity extract from enzyme-deactivated Hinoat flour showed an extreme shear dependence on viscosity. From plots of log (shear rate) against log (relative viscosity) the degree of pseudoplasticity could be estimated from η, the flow behavior index (the smaller the η value, the greater the departure from Newtonian behavior). Oat gum at 1% (wt/vol) showed η values of ~0.2 compared with ~0.3 for guar and locust bean gum. A *M* NaCl solution did not greatly affect viscosity (but on occasion caused precipitation of gum), whereas a 40% sucrose solution brought about a slight reduction in viscosity at all shear rates studied.

Proteins. Some functional properties of oat protein concentrates (prepared by alkaline extraction) were determined and compared with gluten and soy isolate. The emulsifying activity index (*EAI*) and the emulsion stability index (*ESI*) were comparable with other plant proteins. The water-hydration and fat-absorption capacities of the oat proteins were significantly higher than they are for other plant proteins, suggesting that oat proteins may be useful as a meat binder or extender. The ability of the oat concentrates to form a foam and the stability of the foams so formed were similar to gluten but lower than soy isolate.

Albumins, globulins, prolamines, and glutelins were isolated and characterized from the endosperm, germ, and bran tissues of oats.

The protein fractions from bran and endosperm were quite similar but the germ albumins and globulins were quite different from those of endosperm.

Lipids. Studies have continued on lipase activity in oats and oat products. Oat has an eightfold-higher lipase activity than other cereals (wheat, barley, rye). Localization of lipase in the outer layers of bran (aleurone and subaleurone) was confirmed. Effects of temperature (60–100°C) at various moisture levels (7–50%) were investigated. Lipase is inactivated at 100°C at 7% moisture in 1 h and at 70°C at 50% moisture in 30 min. Several commercial products were analyzed for lipase activity. Oat products containing an active lipase were not suitable as a food ingredient as judged by the acceptability of oat cookies.

Under contract research at the University of Ottawa, a radio isotope assay was developed for measuring lipase activity in aqueous suspensions of oat flour. Lipase activity was assayed in developing oat grains from 2 to 44 days postanthesis. Activity increased as grain matured. Varietal differences were noted. Lipase activity increased 50% during germination within the first 12 h of imbibition.

Phenolics. An efficient extraction process was developed for research of low-molecular-weight phenolics from dehulled oats and related cereal grains. The process involved the sequential percolation of solvents of decreasing polarity through short columns packed with the powdered material to be extracted (e.g. hulls, brans, flour). Eluates were monitored both quantitatively by ultraviolet spectrophotometry and qualitatively by high-performance thin-layer chromatography. Examination of the material during the course of extraction by fluorescence microscopy using the flavone–flavonol fluorochrome aminoethyldiphenylborinate ensured virtually complete extraction of flavonoids and related phenolics.

The nature of the phenolics extracted from the grain were studied. These compounds may undergo oxidation and degradation to give deeply colored products that, under certain conditions, can markedly alter protein functionality. A preliminary cleanup and class separation into neutral and acidic fractions was found to be necessary before purification and characterization of the extracted phenolics could be performed. In oat bran, the neutral fraction contained a number of C-glycosylflavones, including vitexin. Tricin, apigenin, luteolin, kaempferol, and quercetin were also identified, along with smaller amounts of at least 30 other components. The acidic fraction contained a complex mixture of phenolics, including a series of chromatographically and spectroscopically distinct chalcone-like constituents. The structures of these acidic phenolics that constituted a major portion of the low-molecular-weight oat phenolics are currently under investigation.

Gelation of evaporated milk. Through a cooperative contract research study it was demonstrated that age-thickening or gelation of evaporated milk was promoted by holding milk concentrate at 4–7°C for 1–3 days before canning and sterilization. The gelation phenomenon was similar to that described by Dutch investigators working with evaporated milk of higher total solids (29–31%).

The possible role of microorganisms or proteases that survived sterilization, alteration of casein micelles, and oxidizing and reducing conditions upon gelation was examined. It was shown that gelation did not result from microbial growth or protease action. Heating samples held for 3 days at 55–60°C for 30 min before canning and sterilization did not prevent gelation. Oxidizing conditions hastened gelation, and reducing conditions delayed gelation but did not prevent it. Studies on this gelation phenomonon are continuing.

Syneresis of acid gels. An objective method was developed to measure susceptibility to syneresis of acid gels. The method consisted of centrifuging the gels for 10 min (in 15-mL centrifuge tubes) at *g* forces ranging from 30 to 1000 *g* and measuring the volume of liquid separated. The volume of liquid separated was plotted against the *g* force, and a quantitative estimate of susceptibility to syneresis was obtained from the slope of the plot.

Frozen storage of printed butter. Butter wrapped in 10 different wrappers (plastics, papers, and an aluminum-foil laminate) was stored for 12 mo at −20°C. Throughout that period oxidized flavor did not develop nor did the level of peroxides increase significantly. Frozen storage of high-quality butter as prints appears to be a satisfactory practice.

Whey utilization. Under contract research whey fractions prepared by reverse osmosis

(RO) or ultrafiltration (UF) have been incorporated into over 30 products, with particular success in processed cheese and cheese foods.

Cottage cheese. It is possible to manufacture cottage cheese curd from highly heated milk so that the denatured whey proteins are retained and apparently form part of the curd structure; yields are increased 10–20%. However, problems are encountered with shattered curd, soft curd, and mealiness. Trials reconfirmed that the use of 5 or 20 mL of rennet per 454 kg of skim milk yielded better curd than the use of 1 or 2 mL of rennet. At 5 and 20 mL of rennet, the optimum pH values of cutting were 5.15 and 5.20, respectively. However, curd still tended to be shattered and mealy but was adequately firm. This was done with a rate of heating that reached 40°C, 75 min after cutting. Preliminary results indicate that faster cooking, e.g. to reach 40°C 30–40 min after cooking, reduced shattering and mealiness.

Lactose crystallization. A thorough study of factors affecting the crystallization of lactose in milk fractionation processes has been completed and data are being reviewed for publication in 1982.

PUBLICATIONS

Research

Amiot, J.; Brisson, C. J.; Delisle, J.; Goulet, G.; Savoie, L.; Jones, J. D. 1981. Nitrogenous products released by in vitro enzymatic hydrolysis of food proteins. Nutr. Rep. Int. 24:515-529.

Bishop, G.; Spratt, W. A.; Paton, D. 1981. Computer plotting in 3-dimensions—A program design suited to food science applications. J. Food Sci. 46(6):1938-1943.

Churms, C. S.; Stephen, M. A.; Siddiqui, I. R. 1981. Evidence for repeating subunits in the molecular structure of the acidic arabinogalactan from rapeseed (*Brassica campestris*). Carbohydr. Res. 94:119-122.

Collins, F. W.; De Luca, V.; Ibrahim, R. K.; Voirin, B.; Jay, M. 1981. Polymethylated flavonols of *Chrysosphlenium americanum*. 1. Identification and enzymatic synthesis. Z. Naturforsch. 36(C):730-736.

Diosady, L. L.; Bergen, I.; Harwalkar, V. R. 1980. High performance liquid chromatography of whey proteins. Milchwissenschaft 35:671-676.

Elliot, J. A.; Millard, G. E.; Holley, R. A. 1981. A late gas defect in cheddar cheese caused by an unusual bacterium. J. Dairy Sci. 64:2278-2283.

Emmons, D. B.; Kalab, M.; Larmond, E.; Lowrie, R. J. 1981. Milk gel structure. 10. Texture and microstructure of cheddar cheese made from whole milk and from homogenized low fat milk. J. Texture Stud. 11:15-34.

Harwalkar, V. R.; Kalab, M. 1981. Effect of acidulants and temperature on microstructure, firmness and susceptibility to syneresis of skim milk gels. Scanning Electron Microsc. 3:503-513.

Harwalkar, V. R.; Modler, H. W. 1981. Whey protein concentrate prepared by heating under acidic conditions. 2. Physico-chemical evaluation of proteins. Milchwissenschaft 36(10): 593-597.

Holley, R. A. 1981. Prevention of surface mold growth on Italian dry sausage by natamycin and potassium sorbate. J. Appl. Environ. Microbiol. 41:422-429.

Holley, R. A. 1981. Review of the potential hazard from botulism in cured meats. Can. Inst. Food Sci. Technol. J. 14:183-195.

Jenkins, K. J.; Emmons, D. B.; Lessard, J. R. 1981. Some in vitro observations on factors affecting rennet (chymosin) clotting of calf milk replacers. Can. J. Animal Sci. 61:393-401.

Jenkins, K. J.; Kramer, J. K. G.; Emmons, D. B. 1981. Digestion of fat in calves fed milk replacers prepared by homogenization or low-pressure dispersion. J. Dairy Sci. 64:1965-1971.

Jenkins, K. J.; Mahadevan, S.; Emmons, D. B. 1980. Susceptability of proteins in calf milk replacers to hydrolysis by various proteolytic enzymes. Can. J. Anim. Sci. 60:907-914.

Kalab, M. 1980. Milk gel structure. 12. Replication of freeze-fractured and dried specimens for electron microscopy. Milchwissenschaft 35(11):657-662.

Kalab, M. 1981. Review: Electron microscopy of milk products—A review of techniques. Scanning Electron Microsc. 3:453-472.

Kalab, M.; Sargant, A. G.; Froehlich, D. A. 1981. Electron microscopy—Study of microstructure in commercial cream cheese. Scanning Electron Microsc. 3:473-482, 514.

McKellar, R. C. 1981. Off-flavors and proteolysis. The development of off-flavors in UHT and pasteurized milk as a function of proteolysis. J. Dairy Sci. 64:2138-2145.

McKellar, R. C.; Shaw, K. M.; Sprott, G. D. 1981. Isolation and characterization of a FAD dependant NADH diaphorase from *Methanospirillum hungatei* strain GPI. Can. J. Biochem. 59:83-91.

Modler, H. W.; Harwalkar, V. R. 1981. Whey protein concentrate prepared by heating under acidic conditions. 1. Recovery by ultrafiltration and functional properties. Milchwissenschaft 39(9):537-547.

Mullin, W. J. 1980. Hydrolysis products from glucosinolates in rutabaga (*Brassica napborassica* Mill). J. Food Technol. 15:163-168.

Mullin, W. J. 1980. Potential errors in the measurement of oxazolidinethiones by U.V. Lebensm. Wiss. Technol. 13:36-37.

Mullin, W. J.; Proudfoot, K. G.; Collins, M. J. 1980. The glucosinolate content and clubroot of rutabaga and turnip. Can. J. Plant Sci. 60:605-612.

Oomah, B. D.; Reichert, R. D.; Youngs, C. G. 1981. A novel, multisample, tangential abrasive dehulling device (TADD). Cereal Chem. 58(5):392-395.

Paton, D. 1981. The behaviour of oat starch in sucrose salt and acid solution. Cereal Chem. 58(1):35-39.

Paton, D.; Larocque, G.; Holme, J. 1981. Development of cake structure. Influence of ingredients on the measurement of cohesive force during baking. Cereal Chem. 58(6):527-529.

Paton, D.; Spratt, W. A. 1980. A simulated approach to the estimation of the degree of cooking of an extruded cereal product. Cereal Chem. 58(3):213-220.

Russell, L. F.; Quamme, H. W.; Gray, J. I. 1981. Qualitative aspects of pear flavor. J. Food Sci. 46:1152-1158.

Sahasrabudhe, M. R.; Quinn, J. R.; Paton, D.; Youngs, C. G.; Skura, B. J. 1981. Chemical composition of white bean (*Phaseolus vulgaris*) and functional characteristics of its air-classified protein and starch fractions. J. Food Sci. 46(4):1079-1081, 1087.

Sarwar, G.; Bell, J. M.; Sharby, T. F.; Jones, J. D. 1981. Nutritional evaluation of meals and meal fractions derived from rape and mustard seed. Can. J. Anim. Sci. 61:719-733.

Shah, B. G.; Benns, G.; Nera, E. A.; Verdier, F. C.; Beare-Rogers, J. L.; Jones, J. D.; Ohlson, R.; Anjou, K. 1981. Iodine metabolism and tissue mineral levels in rats fed rapeseed protein concentrates supplemented with zinc. Qual. Plant. Plant Foods Hum. Nutr. 30:234-243.

Shah, B. G.; Nera, E. A.; Verdier, P. C.; Beare-Rogers, J. L.; Jones, J. D.; Anjou, K.; Ohlson, R. 1981. Growth, blood chemistry and histology of rats fed zinc-supplemented rapeseed protein concentrates. Qual. Plant. Plant Foods Hum. Nutr. 30:223-233.

Siddiqui, I. R.; Nestor, R.; Benzing, L. 1981. Amadori compound from tobacco. Carbohydr. Res. 94:C19-C23.

Stanely, D. W.; Emmons, D. B.; Modler, H. W.; Irvine, D. M. 1980. Cheddar cheese made with chicken pepsin. Can. Inst. Food Sci. Technol. J. 13:97-102.

Wood, P. J. 1981. The use of dye–polysaccharide interactions in β-D-glucanase assay. Carbohydr. Res. 94:C19-C23.

Miscellaneous

Emmons, D. B. 1981. Utilization of dairy proteins. Pages 247-259, Chapter 12 *in* Utilization of protein resources. Stanley, D. W.; Murray, E. D.; Lees, D. H., eds. Food and Nutrition Press, Inc., Westport, CT.

Jenkins, K. J.; Sauer, F. D.; Emmons, D. B.; Larmond, E. 1981. Soluble fish protein in milk replacers give good calf performance. Canadex 401.64.

Paton, D.; Sosulski, F.; Madl, R. L. 1981. Method for water hydration capacity of plant protein material. Cereal Foods World 26(6):291-293.

Land Resource Research Institute

Ottawa, Ontario

PROFESSIONAL STAFF

J. S. Clark, B.S.A., M.Sc., Ph.D.	Director
J. C. van Schaik, M.Sc., Ph.D.	Deputy Director
M. B. Trudel	Administrative Officer

Soil Resource Inventory and Mapping

J. H. Day, B.S.A., M.S.A.	Head of Section; Correlation
J. A. Shields, B.S.A., M.Sc., Ph.D.	Soil Correlation—Great Plains
C. Tarnocai, B.S.F., M.S.	Soil Correlation—British Columbia and North

Atlantic Soil Survey (Truro)

F. Hender, B.Sc.	Party leader
P. K. Heringa, B.Sc., M.Sc.	Party leader
D. A. Holmstrom, B.S.A.	Party leader
J. I. MacDougall, B.Sc., B.Sc. (Agr.)	Party leader
H. W. Rees, B.Sc.	Party leader
K. T. Webb, B.Sc., M.Sc.	Party leader

Quebec Soil Survey (Sainte-Foy)

J. M. Cossette, B.Sc.	Head of Unit
L. Grenon, B.S.A.	Party leader
L. Lamontagne, B.Sc.	Party leader
M. C. Nolin, B.Sc., M.Sc.	Party leader
R. Simard, B.S.A., M.Sc.	Party leader

Ontario Soil Survey (Guelph)

C. J. Acton, B.S.A., M.Sc., Ph.D.	Head of Unit
B. H. Cameron, B.Sc (Agr.)	Party leader
R. K. Jones, B.Sc., M.Sc.	Party leader
E. W. Presant, B.S.A., M.Sc.	Party leader

G. J. Wall, B.S.A., Ph.D.	Party leader

Manitoba Soil Survey (Winnipeg)

R. E. Smith, B.S.A., M.Sc.	Head of Unit
R. Eilers, B.S.A., M.Sc.	Party leader
W. R. Fraser, B.Sc., M.Sc.	Party leader
W. Michalyna, B.S.A., M.Sc., Ph.D.	Party leader
H. Veldhuis, Ing., M.Sc.	Party leader

Saskatchewan Soil Survey (Saskatoon)

D. F. Acton, B.S.A., M.Sc., Ph.D.	Party leader
A. K. Ballantyne, B.S.A., M.Sc.	Party leader
L. M. Kozak, B.S.A., M.Sc., Ph.D.	Party leader
G. Padbury, B.S.A., M.Sc.	Party leader
H. P. W. Rostad, B.S.A., M.Sc., Ph.D.	Party leader
W. E. Souster, B.A., B.S.A., M.Sc., Ph.D.	Party leader
H. B. Stonehouse, B.S.A., M.Sc.	Party leader

Alberta Soil Survey (Edmonton)

W. W. Pettapiece, B.S.A., M.Sc., Ph.D.	Head of Unit
G. M. Coen, B.Sc., M.Sc., Ph.D.	Party leader
A. A. Kjearsgaard, B.Sc.	Party leader
G. T. Patterson, B.Sc., M.Sc.	Party leader
J. Tajek, Eng.	Party leader

British Columbia Soil Survey (Vancouver)

T. M. Lord, B.S.A.	Head of Unit
A. J. Green, B.S.A., M.Sc.	Party leader
D. E. Moon, B.Sc., Ph.D.	Party leader
C. J. Selby, B.Sc., M.Sc.	Party leader
K. W. G. Valentine, B.S.A., M.Sc., Ph.D.	Party leader
L. J. P. van Vliet, B.S.A., M.Sc.	Party leader

Soil Classification

J. A. McKeague, B.A., B.S.A., M.Sc., Ph.D.	Head of Section; Classification
C. A. Fox, B.A., M.Sc., Ph.D.	Micromorphology
P. E. M. Lévesque, B.S.A., M.S.A., Ph.D.	Organic soils
S. P. Mathur, B.Sc., Assoc. I.A.R.I., Ph.D.	Organic soils
G. C. Topp, B.S.A., M.S., Ph.D.	Physics and water
C. Wang, B.S.A., M.Sc., Ph.D.	Chemistry
G. Wilson, B.Sc., M.Sc., D.I.C.	Engineering

Land Use and Evaluation

J. Dumanski, B.S.A., M.Sc., Ph.D.	Head of Section
D. R. Coote, M.S., Ph.D.	Degradation
J. Culley, B.Sc., M.Sc.	Water quality
R. DeJong, B.Sc., M.Sc., Ph.D.	Water use
B. Kloosterman, B.S.A., Ph.D.	Data system
K. B. MacDonald, B.S.A., M.Sc., Ph.D.	Evaluation
K. Switzer-Howse, B.Sc.	Information

Agrometeorology

A. R. Mack, B.S.A., M.Sc., Ph.D.	Acting Head of Section; Remote sensing
W. Bailey, B.Sc., Ph.D.	Climatology
R. L. Desjardins, B.Sc., M.A., Ph.D.	Micrometeorology
L. M. Dwyer, B.Sc., M.Sc., Ph.D.	Environmental meteorology
S. N. Edey, B.Sc.	Applications
H. N. Hayhoe, B.Sc., M.S., Ph.D.	Biomathematics
D. W. Stewart, B.S.A., M.Sc., Ph.D.	Crop–weather modeling

Departures

G. J. Beke, B.S.A., B.Sc., Ph.D. Transferred to Lethbridge Research Station, 18 March 1981	Head of Unit, Truro
J. C. W. Keng, B.S., M.Sc., Ph.D. Transferred to Agassiz Research Station, B.C., 1 September 1981	Physics structure
J. L. Nowland, B.A., M.Sc. Seconded to Program Coordination, 15 May 1981	Soil Correlation—Eastern
T. W. Peters, B.Sc., M.Sc. Retired 13 February 1981	Party leader
R. E. Wells, B.Sc., M.Sc., Ph.D. Resigned 19 June 1981	Party leader

INTRODUCTION

The Land Resource Research Institute (LRRI) was established in 1978 to bring together the main professional disciplines involved in agricultural land resource studies in Agriculture Canada. In this, its 3rd yr of operation, the activities in the Institute continued to focus on the assembly and integration of information on land forms, soils, and climate and their interactions relative to the evaluation of the land resources for potential agricultural and related uses; the collection and synthesis of information on the seasonal dynamics of weather and its effects on land use and food production; and the undertaking of research as required to meet the needs of the first two functions. Regional programs have been maintained through regional soil survey units working in cooperation with Provincial survey agencies.

This report briefly outlines the activities and achievements during 1981. Requests for details should be addressed to the Land Resource Research Institute, Agriculture Canada, Ottawa, Ont. K1A 0C6.

J. S. Clark
Director

INSTITUTE ROLES

The activities of LRRI include research, development, and services related to Canada's land resources. These activities not only support other research within the Research Branch but also provide information essential to policy and decision-making for regional and national levels of governments, educational institutions, and agri-business. The Institute in pursuit of these activities provides leadership and is responsible for a number of national programs related to land, including those outlined below.

Soil inventory. Soil mapping is done by LRRI staff in cooperation with provincial and university personnel throughout the nation, and correlation provides quality control on soil maps and reports. Maps are prepared showing the distribution of soils and land capability for various potential uses.

Canada soil information system (CanSIS). Soil survey, soil management, crop yield, and cartographic data are stored in a computerized system so as to be available to users throughout Canada.

Soil taxonomy and interpretations. Improvements are developed in taxonomic and interpretive soil classification systems through research and integration of information from many sources.

Land evaluation. Data on soils, climate, agronomy, and economics are being integrated to develop improved methodology for predicting crop yield potentials and assessing the quality of the land resources of Canada for various uses.

Agrometeorological data archive. Agrometeorological data and processing services are provided.

Crop information system and agroclimatic resources. Procedures are developed monitoring the areal distribution of growing conditions and crop production prospects from meteorological, environmental, remotely sensed agriclimatic, and crop statistical data. Agroclimatic resources are assessed to provide information for efficient management of agricultural resources.

Committees. LRRI contributes to the integration of land-related activities of Agriculture Canada and other federal and provincial agencies through participation in a number of committees. These include:

- Canada Committee on Land Resource Services (CCLRS) and the associated expert committees
- Provincial agricultural services coordinating committees and soil survey committees
- Canada Committee on Ecological Land Classification
- Interdepartmental Committee on Land Use
- Interdepartmental Committee on Water
- Geotechnical Committee of the National Research Council and the Peatland Subcommittee

- Canada Advisory Committee on Remote Sensing
- Committee on Great Lakes Water Quality
- Interdepartmental Committee on Air Surveys

INSTITUTE PROGRESS AND ACHIEVEMENTS DURING 1981

Soil resource inventory and mapping

The soil resource inventory and mapping program involves personnel of the soil survey units throughout Canada and a group at Headquarters of the Land Resource Research Institute in Ottawa concerned with soil correlation and cartography. The survey projects are conducted in cooperation with personnel of provincial agencies according to priorities that are established in the provinces through consultation and mutual agreements. Many of the federal soil survey units share offices and other facilities with their provincial counterparts. The report that follows includes only the resource inventory and mapping carried out mainly by the federal soil survey staff.

Newfoundland. Soil survey reports were completed for the Terra Nova development area, Gander Lake sheet, Red Indian–Burgeo area, Avalon Peninsula, and Bonavista sheet. Mapping was completed in the Green Bay area.

Prince Edward Island. All manuscript maps were completed and the generalization from 1:10 000 to 1:75 000 is in progress. The preliminary soil report for the province was published. Additional mineral and organic soil sites were characterized and sampled.

Nova Scotia. Preliminary maps for Colchester and Pictou counties were completed. Hants County legend was compiled and mapping of 2500 ha was initiated in the eastern quarter. Soil acidity, water tables, and soil temperature were monitored at various sites.

New Brunswick. Preparation of the report and maps for Chipman–Minto–Harcourt area is in progress; exploratory survey in central northern areas was held in abeyance due to staff vacancy; an organic soil mapping and interpretation workshop was conducted; soil temperature and moisture regimes were monitored at the Research Station. Sussex phase II was 70% completed and introductory sections of the report were written.

Quebec. Detailed mapping was continued (28 935 ha) in Richelieu County. Reconnaissance mapping for legend establishment and soil characterization was completed in Vercheres County. In the St.-Hyacinthe County the correlation of soil and correction of maps was 75% completed.

Ontario. In the Haldimand–Norfolk project 13 final soil maps were submitted to Headquarters with legends. Soil analyses and interpretations for soil capability, tobacco, forestry, and erosion were completed. The Middlesex soil report draft was edited. The relationship between forest productivity and soils was studied in Huronia and Lindsay districts. A mapping and classification system for the forested claybelt region was partly developed; a guide using key soil properties in the field for the recognition of ecosystem types was completed. A report on soil erosion susceptibility was prepared for Haldimand–Norfolf, and the Agriculture Canada publication *Soil Erosion by Water* was partially revised. At the request of the Ontario Ministry of Agriculture and Food a study was undertaken to evaluate the agricultural strategy employed by Ontario Hydro in selecting hydro transmission line routes in southwestern Ontario. Soil mapping was conducted in the Niagara region (9600 ha); a preliminary soil map for West Lincoln township was compiled.

Manitoba. Planned detailed resurveys were completed on approximately 173 400 ha in nine selected areas in southern Manitoba, mostly in areas surrounding rural townsites and intensive outdoor recreation developments in provincial parks. Interim reports were completed for the Pelican-Rock Lakes (D19), West Portage (D20), West Interlake Planning District (D36), Duck Mountain (D42), South Central Escarpment area (D45), Roblin (D47), Pine Creek–Cypress River (D50), and Brandon Planning District (D51), and a 1:1 000 000 scale generalized soil map of Manitoba was prepared. Irrigation suitability standards and guidelines for rating soils in southern Manitoba were revised and published.

Saskatchewan. Approximately 274 000 ha were mapped in the soil inventory program. Soil maps were compiled and advance copies printed for nine municipalities and a report

was completed for one municipality. Improved methods for collecting and managing soil survey data and making soil interpretations were developed, and improved planning and correlation procedures were implemented. Reports were published for the Green Lake–Waterhen and Hudson Bay–Swan Lake map area and the Swift Current and Weyburn–Virden map area. A map on the extent of salinity and sensitivity to salinization was compiled for most of the agricultural region. A summary report on deep plowing Solonetzic soils was completed, and a report on the effect of acidic deposition on soils of northern Saskatchewan was published. A research site was established to monitor the relationship between soil moisture and temperature regimes and the properties of wetland soil areas.

Alberta. The Brazeau Dam area report and a 1:1 000 000 map of Solonetzic soils in Alberta were published. The Newell County report was submitted for publication and interim copies (with published maps) were made available to local users. Mapping of 94 000 ha completed the field work in Warner County. Maps of the previously mapped 360 000 ha were made available to local research and county personnel, and final map compilation and report writing are under way. The Banff–Jasper and Yoho national parks biophysical reports have been submitted for publication. A report relating reported crop yields to Canada Land Inventory soil capability ratings and soil types was published.

British Columbia. The soil maps and report for Quesnel were published; the Horsefly and Barkerville reports and maps were submitted for publication. Ten chapters of *Soil Landscapes of Canada* were completed and the map was drafted. The Mill–Woodfibre map folio was completed; the report manuscript is under revision. The Power River maps were completed and map unit information has been stored in the computer. The soil maps for Saltspring Island were completed and the first draft of the report was prepared. Soil erosion loss data for Peace River plots were evaluated and summarized. These data underscore the urgency of the land degradation assessment proposed by the Land Resource Research Strategy.

Ottawa. Field correlation tours were conducted in cooperation with federal or provincial senior surveyors in numerous areas, and soil report manuscripts and map legends were reviewed prior to production. The report and maps for the Firth and Horton rivers project was completed. A *Wetlands of Canada* map was published and a book on the Wetlands of Canada was planned and partially compiled by members of the Wetlands working group. Field mapping was conducted in Viscount Melville Sound area, and in the Old Crow (YT) area in cooperation with archeologists from the National Museums. A legend and symbology for generalized soil landscape maps were completed for Saskatchewan and Manitoba, and a small-scale soil landscape map was compiled for southern Saskatchewan. Soil physical data were summarized for the south Saskatchewan irrigation project. A paper on the development of methodology for using Landsat data to monitor agricultural land use changes was presented.

Cartography. Maps completed were: soils 67, special projects 23, miscellaneous 267, CanSIS input 163 plus 183 made error-free, CanSIS derived maps 162, Canada Land Inventory 17, Northern Land Use 29, British Columbia coastal resource folio 90, Nahanni National Park vegetation 2.

Soil classification

Research of the soil classification section supports soil inventory and interpretations and adds new information on soil properties and genesis. Progress is reported for each of the three projects: organic soils, mineral soils, and soil water-structure.

Organic soils. Criteria were established for the safe use of copper as an amendment for cultivated organic soils. The treatment can reduce subsidence of organic soils by approximately 50% and increase yields of some crops without causing adverse effects on either the nutritional value of the crop or the quality of the groundwater. The recommended copper treatment neither destroys soil microbes nor inactivates intracellular enzymes involved in mineralization of organic nitrogen.

The effect of cultivation on subsidence of peat was studied in a peat deposit, of which only a part was cultivated. Marked subsidence in the cultivated area was due to chemical changes only in the cultivated layer and the physical changes extending from the surface to well below the cultivated layer. Palynology (pollen analysis) was useful in establishing synchronous layers in the cultivated and uncultivated materials.

Five research papers and eleven miscellaneous articles were published on various aspects of organic soils.

Mineral soils. Further testing of the transect method was completed and a report was prepared showing how the method can be used in establishing map units in new survey areas and in checking the reliability of soil maps.

Detailed analysis of three pedons from New Brunswick, including calculations of gains and losses of constituents in horizons, showed that eluviation of clay from Ae horizons and deposition of clay in B horizons are major processes in the genesis of sandy Podzolic soils of the area. Micromorphological and other evidence indicated that silicate clay is probably translocated with organic matter–Fe,Al complexes.

Analysis of a Podzolic pedon developed from chlorite schist in New Brunswick supported evidence of laboratory studies in showing that chlorite is transformed to smectite in the Ae horizon.

Studies of soils associated with outcrops of saprolite (weathered rock) in Cape Breton and northern Central New Brunswick showed that gibbsite and kaolinite formed millions of years ago from weathering of granitic rocks may be components of soils of the area.

Energy-dispersive X-ray analysis (EDXRA) of iron-rich nodules in Aeg horizons of some soils from the Peace River area of Alberta showed that parts of some nodules contained up to 10% P, an enrichment of 200-fold from the adjacent soil matrix. EDXRA was shown to be a powerful tool in demonstrating the segregation of soil constituents and in determining the composition of soil features in thin sections.

Eight research papers and three miscellaneous articles were published or are in press.

The soil laboratory analyzed some 3400 soil samples mainly from soil survey units in the Atlantic Provinces; other clients were the Ontario and British Columbia soil survey units and all sections of LRRI in Ottawa. In addition, some 1000 water samples, manure samples, and others were analyzed (approximately 22 000 total determinations). Some soil analysis was done for other agencies of Agriculture Canada and for other federal agencies. Improved facilities for soil physical analysis resulted in improved output of water-retention data.

Soil water-structure. The time-domain reflectrometry (TDR) method of measuring soil water was developed further and a pilot industry laboratory program (PILP) contract was let for the development and testing of a prototype instrument. Testing and evaluation of this instrument is in progress. Two papers on application of TDR are in press. Improved procedures were developed for measuring the lateral and vertical components of saturated flow of water into an auger hole, and for measuring the contribution of large macropores to water flow in soils; testing of these procedures is in progress.

Guidelines were developed for estimating saturated hydraulic conductivity, K_{sat}, from soil morphology; preliminary testing in soils of the St. Lawrence Lowlands showed that the guidelines resulted in correct estimates of the K_{sat} class (eight classes) in more than 40% of cases and estimates within 1 of the correct class in 90% of cases.

Shrinkage of disturbed and undisturbed soil samples was measured in order to determine the effect of shrinkage and swelling on the widths of planar voids as measured in soil thin-sections. Methods were tested for preparing soil thin-sections without altering pore dimensions; no ideal solution to the problem was found.

Land use and evaluation

The land use and evaluation program undertakes to develop improved techniques for integrating and interpreting soil climate, landform, agronomic, and economic data to evaluate the production potential of land for alternate agricultural uses. Progress for each of the projects is as follows.

Canada soil information system (CanSIS). A study of necessary hardware and software to upgrade the Calcomp 748/975 flat bed plotter was completed. A proposal involving raw data handling (cartographic) on Data Crown facilities was rejected because of costs. Turnaround documents for derived maps were translated into French and a contract was let to convert cartographic symbols for typesetting.

Some updates to the land potential data base were completed, a new version of RAPID (3.0) was implemented, and the WARDEN file for Parks Canada was revised. A position paper for CanSIS and a brochure explaining the system is being prepared.

Several training courses were conducted for Soil Survey and Parks Canada personnel.

Crop production potentials. A bulletin on a modeling method for assessing crop production potentials on a broad scale was published, and a series of five internal reports was prepared summarizing the data handling and output capabilities of the performance/management file of CanSIS. A paper was submitted on empirical relations between soil properties and water retention (33.4 and 1520 kPa), a report on estimating bulk density from particle size and organic carbon was prepared, and a computer file of unsaturated hydraulic conductivity data was prepared. The bulletin *Acid Soils and Liming* (No. 869) was revised for publication.

Resource protection. Five bulletins were prepared and submitted for publication relating to soil degradation, acid rain, and water quality maintenance in agricultural areas. Four scientific papers were prepared on field measurement techniques for degradation assessment, pipeline effects on crop productivity, microbiological effects of manure runoff, and land application of swine manure. Some criteria and procedures of degradation assessment were prepared for application by the soil survey group, a chapter on erodibility indices was prepared for inclusion in Ontario soil survey reports, field measurements of erodibility were conducted in Niagara and Haldiman–Norfolk areas, and erosion studies in the Peace River area were continued.

Manure plots at the Central Experimental Farm and water quality sites in the South Nation Catchment were monitored. Studies on N application and pollution, seepage from unlined liquid manure storages, and remedial measures to control agricultural pollution in the Thames River basin were continued. Over 200 land-drainage proposals for the Eastern Ontario Subsidiary Agreement were reviewed. A new study on the economic impact of land drainage and agricultural land use was begun.

Land use and socioeconomic evaluation. Bulletins were published on national crop production potentials for land evaluation and on climate and soil requirements for crops. A scientific paper describing the association between crop distribution in Canada and soil type was submitted, and an invitational paper summarizing agricultural land use concerns in Canada was prepared for a symposium sponsored by the American Society of Agronomy. A research report describing soil data stored in CanSIS was prepared for the Expert Committee on Agrometeorology, and a package of special data on wheat production potentials was prepared for the Canada Grains Council. A scientific paper describing the philosophy of agricultural land evaluation was published by a researcher under contract (Smit, B. 1981. J. Soil Water Conserv. 36(4):209-212). A draft manuscript on a user's manual for the land potential data base was prepared.

Forty-six map sheets of the Niagara land-use survey were compiled and the economic data for the Niagara, Melville, and Ottawa areas were analyzed by computer for extended legends. A land-use classification was developed for the Haldiman–Norfolf area in preparation for the survey in 1982–1983. The study relating land use systems to soil characteristics using information theory statistics has been expanded to include data from the Melville and Niagara areas, as well as from Ottawa.

Agrometeorology

Agrometeorology is concerned with the interaction of weather parameters that affect plant development, crop production, and farm management practices. Discovery and definition of the relationships, seasonal variability, and agroclimatic parameters are carried out for assessing current cron production and climatic limitations of agricultural regions, particularly for the production of basic food supplies. The application of these studies for climatic evaluation of land resources, for environmental impact assessment, improved farm management practices, and timely market information on crop conditions throughout the growing season is of primary concern.

Applications. The soil moisture evaluation project (SMEP) provided up-to-date weekly information on the availability of soil moisture for each of the crop-reporting districts of Western Canada, based on meteorological data from a 90-km grid network. Modifications of the mapped data were made for special reports and information on the status of drought conditions on the prairies. Daily agrometeorological data, long-term climatological records, and data processing support were provided for studies on soil moisture, grasshopper outbreaks, soil temperatures,

crop-weather modeling, spectral analyses of crop growth, and absorption of CO_2 by field crops. Data and computer services are provided for mapping of Canadian agroclimatic resources. Further progress was made in acquiring daily precipitation and temperature data on a 50-km grid for improved crop yield estimates.

Crop information. Studies started in 1972 on the first phase of using remotely sensed data from Landsat for analyzing crop conditions were completed. Satellite imagery acquired over test areas of spring- and fall-seeded crops in Canada and the United States has been successfully processed for determining hectarage and crop conditions of cereal, oil-seed, and several specialty crops. Software programs have been developed for overlaying soil climatic and legal survey information on satellite imagery and were used for locating selected agricultural areas, land features, and crop districts on successive years of imagery. The procedures may be adapted for pilot system applications and test operation evaluation if current information on crops is required. Several demonstration projects were carried out in cooperation with the Canada Center for Remote Sensing on assessing fallowland and rangelands, and estimating of salt-affected crops. Measurements of land area left in fallow in 1979 in Saskatchewan showed the proportion of fallow varied from 18% in a crop district (8B) in the Chernozemic soil zone, to 31% in a crop district (7B) in Dark Brown soil zone, to 38% in a district (1A) in the Brown soil zone. Yield estimates based on Canadian meteorological data for the crop-reporting districts of the prairie region were provided weekly during the summer for the three major cereal crops. The yield estimates made regularly on a trial operational basis during the growing season for the last 2 yr coincide closely with the final harvested yield values where reliable precipitation data were available. The soil moisture data (SMEP) complemented the yield estimates and provided information on the amount of moisture available to carry the estimated crop to maturity should rainfall be limited. Analysis of airborne microwave imagery previously acquired under the Canadian surveillance satellite program for selected agricultural test sites showed the feasibility of analyzing crop growth from multi-band radar data. The radar data could thus be used during adverse weather conditions for acquiring imagery that would complement imagery acquired from standard aerial photography or from resource-imaging satellites taken during clear atmospheric conditions.

Crop–weather analyses. Research on identifying alternative parameters for assessing environmental conditions and crop growth was carried out. The exchange of carbon dioxide was measured using airborne and ground-based observations. Analyses of spectral-reflectance data based on the visible-to-near infrared ratios were carried out to obtain rapid measurements of leaf-area expansion of crops for use in estimating crop yields and growing conditions.

Initial studies show that severity of water stress in crops may be determined from measuring the basal leaf-water potential. Models were developed illustrating the response of stomatas to the osmotic status of plants in relation to the plant-water deficit. Other models were developed for simulating soil temperatures and soil moisture based on water diffusion principles, and for estimating protein content of hard red spring wheat for a crop-reporting district from weather data.

Agroclimatic resources. Twelve new maps were published as part of the *Agroclimatic Atlas of Canada.* These maps represent the long-term soil water reserves in the spring (1 May and 20 May) and the water deficits throughout the growing season for spring wheat grown on four different soil textures (prairie region of Canada).

Uniform productivity areas have been delineated from Landsat imagery and evaluated in relation to historical yields and major physical features of the soil in cooperation with the land assessment group of the LRRI. The stratifying of Landsat imagery into uniform productivity areas greatly enhanced the analyses of crops grown under similar agronomic and cultural conditions.

PUBLICATIONS

Research

Bailey, W. G. 1981. The climate resources for agriculture in northwestern Canada. Agric. For. Bull. 4:11-17.

Bailey, W. G.; Davies, J. A. 1981. The effect of uncertainty in aerodynamic resistance on evaporation estimates from the combination model. Boundary-Layer Meteorol. 20:187-199.

Bailey, W. G.; Davies, J. A. 1981. Bulk stomatal resistance control on evaporation. Boundary-Layer Meteorol. 20:401-405.

Bailey, W. G.; Davies, J. A. 1981. Evaporation from soybeans. Boundary-Layer Meteorol. 20:417-428.

Brach, E. J.; Desjardins, R. L.; St-Amour, G. 1981. Open-path CO_2 analyzer. J. Phys. E. Sci. Instrum. 14:1415-1418.

Culley, J. L. B.; Phillips, P. Q.; Hore, F. R.; Patni, N. K. 1981. Soil chemical properties and removal of nutrients by corn resulting from different rates and timing of liquid during manure applications. Can. J. Soil Sci. 61:35-46.

Darwent, A. L.; Bailey, W. G. 1981. Soil moisture and temperature response to shallow tillage in the early spring. Can. J. Soil Sci. 61:455-460.

DeJong, R.; Shaykewich, C. F. 1981. A soil water budget model with a nearly impermeable layer. Can. J. Soil Sci. 61:361-371.

DeJong, R.; Shaykewich, C. F.; Reimer, A. 1980. The net radiation flux and its prediction at Pinawa, Manitoba. Agric. Meteorol. 22:217-225.

Dwyer, L. M.; Merriam, H. G. 1981. Influence of topographic heterogeneity on deciduous litter decomposition. Oikos 37:228-237.

Hayhoe, H. N. 1981. Analysis of a diffusion model for plant root growth and an application to plant soil-water uptake. Soil Sci. 131:334-343.

Lévesque, M.; Jacquin, F.; Polo, A. 1980. Comparative biodegradability of Sphagnum and sedge peats from France. Proc. 6th Int. Peat Congr. (Duluth, USA). pp. 584-590.

Lévesque, M. P.; Mathur, S. P.; Morita, H. 1981. A feasibility study on the possible use of cellulose content for characterizing Histosols (organic soils). Commun. Soil Sci. Plant Anal. 12:415-425.

Lévesque, M.; Polo, A. 1981. Micromorphological, botanical and chemical aspects of peats from Bauptebog (Manche), France. Proc. Peat Symp., Bemidji, MN.

Mathur, S. P.; Preston, C. M. 1981. The effect of residual fertilizer copper on ammonification, nitrification and proteolytic population in some organic soils. Can. J. Soil Sci. 61:445-450.

Mathur, S. P.; Sanderson, R. B. 1980. Relationships between copper contents, rates of biodegradation and degradative enzyme activities of some cultivated organic soils in Ontario, Canada. Proc. 6th Int. Peat Congr. (Duluth, USA). pp. 628-632.

McKeague, J. A. 1981. Phosphorus enriched soil nodules detected by energy dispersive X-ray spectrometry. Soil Sci. Soc. Am. J. 45:910-912.

McKeague, J. A. 1981. SEM-EDXRA as an extension of light microscopy in soil characterization and genesis studies. *In* E. B. A. Bisdom, ed. Submicroscopy of soils and weathered rocks. Pudoc, Wageningen, The Netherlands.

McKeague, J. A.; Kodama, H. 1981. Imogolite in cemented horizons of some British Columbia soils. Geoderma 25:189-197.

McKeague, J. A.; Wang, C.; Ross, G. J.; Acton, C. J.; Smith, R. W.; Anderson, D. W.; Pettapiece, W. W.; Lord, T. M. 1981. Evaluation of criteria for argillic horizons (Bt)of soils in Canada. Geoderma 25:63-74.

Morita, H.; Lévesque, M.; Mills, G. F. 1980. Dioxy-sugars and other neutral monosaccharides derived from Riverton, Man. organic soil profiles. Can. J. Soil Sci. 60:211-217.

Ouellet, C. E.; Desjardins, R. L. 1981. Interprétation des relations entre le climat et la survie à l'hiver de la luzerne par l'analyze des correlations. Can. J. Plant Sci. 61:945-954.

Patni, N. K.; Phillips, P. A.; Hore, F. R.; Culley, J. L. B. 1981. Groundwater quality near concrete manure tanks and under heavily manured cropland. Can. Agric. Eng. 23:37-43.

Pettapiece, W. W.; Kjearsgaard, A. A. 1981. Some considerations regarding the irrigability of soils in east-central Alberta. Can. Water Res. J. 6(1):106-121.

Phillips, P. A.; Culley, J. L. B.; Hore, F. R.; Patni, N. K. 1981. Pollution potential and corn yields from selected rates and timing of liquid manure applications. Trans. Am. Soc. Agric. Eng. 24:139-144.

Preston, C. M.; Mathur, S. P.; Rauthan, B. S. 1981. The distribution of copper, amino compounds and humus fractions in organic soils of differing copper content. Soil Sci. 131:344-352.

Smith, C. A. S.; Coen, G. M.; Pluth, D. J. 1981. Soils with Luvisolic-like morphologies in the Upper Subalpine zone of the Canadian Rockies. 1. Stratigraphy and mineralogy. Can. J. Soil Sci. 61:325-335.

Smith, C. A. S.; Coen, G. M.; Pluth, D. J. 1981. Soils with Luvisolic-like morphologies in the Upper Subalpine zone of the Canadian Rockies. 2. Genesis. Can. J. Soil Sci. 61:337-350.

Valentine, K. W. G. 1981. A national system for mapping soils in Canada: the reasons and some problems. Soil Surv. Land Eval. 1(2):26-35.

Valentine, K. W. G. 1981. How soil map units and delineation change with survey intensity and map scale. Can. J. Soil Sci. 61:535-551.

Van Vliet, L. J. P.; Wall, G. J. 1981. Soil erosion losses from winter runoff in southern Ontario. Can. J. Soil Sci. 61:451-454.

Wang, C.; Kodama, H.; Miles, N. M. 1981. Effects of various pretreatments on X-ray diffraction patterns of clay fractions of Podzolic B horizons. Can. J. Soil Sci. 61:311-316.

Wang, C.; Ross, G. J.; Rees, H. 1981. Characteristics of residual and colluvial soils developed on granite and of the associated Pre-Wisconsin landforms in northern central N.B. Can. J. Earth Sci. 18:487-494.

Zoltai, S. C.; Tarnocai, C. 1981. Some nonsorted patterned ground types in northern Canada. Arct. Alp. Res. 13:139-151.

Miscellaneous

Adams, G. D.; Boissonneau, A. N.; Hirvonen, H. E.; Mills, C. G.; Oswalt, E. T.; Pettapiece, W. W.; Tarnocai, C.; Wells, E. D.; Zoltai, S. C. 1981. Wetlands of Canada maps (wetland regions and distribution of wetlands). Ecological Land Classification Series, No. 14, Environment Canada; two 1:7 500 000 scale maps.

Bailey, W. G. 1981. Agricultural climate resources for northwestern Canada. Bull. Am. Meteorol. Soc. 62:145.

Brach, E. J.; Desjardins, R. L.; Lord, D.; Dubé, P. A. 1981. Field spectrometer to measure percent ground coverage and leaf area index of agricultural crops. Proc. Int. Colloq. Spectral signatures of object in remote sensing. Paris, France. pp. 1-7.

Coote, D. R. 1980. Agricultural needs and responsibilities for water resources. Pages 141-158 *in* Perspectives on Natural Resources; III—Water. Proc. Symp. Sir Sanford Fleming College, Lindsay, Ont. (7–8 Nov. 1979).

Coote, D. R.; Dumanski, J.; Ramsey, J. F. 1981. An assessment of the degradation of agricultural lands in Canada. Land Resource Research Institute, Agriculture Canada, Ottawa, Ont. LRRI Tech. Bull. 96 pp.

Coote, D. R.; Siminovitch, D.; Singh, S. S.; Wang, C. 1981. The significance of acid rain to agriculture in Eastern Canada. Research Branch, Agriculture Canada, Ottawa, Ont. 26 pp.

Culley, J. L. B.; Dow, B. K.; Presant, E. W.; MacLean, A. J. 1981. Impacts of installation of an oil pipeline on productivity of Ontario cropland. Land Resource Research Institute, Agriculture Canada, Ottawa, Ont. LRRI Tech. Bull. 88 pp.

DeJong, R. 1981. Water in the shallow subsurface. Pages 10-17 *in* Canada water year book 1979–1980. Water Research Edition. Environment Canada.

Desjardins, R. L.; Alvo, P.; Brach, E. J.; Schuepp, P. H. 1981. Carbon dioxide exchange using aircraft-mounted sensor. Proc. 15th Conf. Agriculture and forest meteorology, California. pp. 152-154.

Dubé, P. A. 1981. Climate and soil requirements for economically important crops in Canada. E. Small, J. Dumanski, and J. Lendvay-Zwickl, eds. Land Resource Research Institute, Agriculture Canada, Ottawa, Ont. LRRI Tech. Bull. 118 pp.

Dumanski, J.; Stewart, R. B. 1981. Crop production potentials for land evaluation in Canada. Land Resource Research Institute, Agriculture Canada, Ottawa, Ont. LRRI Tech. Bull. 79 pp.

Dwyer, L. M.; Stewart, D. W.; Desjardins, R. L. L981. Development of a simple physical growth model for corn. Pages 213-221 *in* R. Weiss, ed. Computer techniques and meteorological data applied to problems of agriculture and forestry. Final Report of the National Service Foundation.

Geib, P. C.; Crown, P. H.; Mack, A. R. 1981. Bibliography on application of remote sensing and aerial photography to agricultural crops, soil resource and land use. Supplement to 1980. Agrometeorology Section, Research Branch, Agriculture Canada, Ottawa, Ont. 64 pp.

Halstead, R. L.; Dumanski, J. 1981. A strategy for agricultural land resource research. An Update. Special Publ. Can. Comm. Land Resource Service, Agriculture Canada, Ottawa, Ont. 128 pp.

Head, W. K.; Anderson, D. W.; Ellis, J. G. 1981. The soils of the Wapawikka, map area 73-I. Saskatchewan Institute of Pedology Publ. SF5. 108 pp.

Heringa, P. K. 1981. Soils of the Avalon Peninsula, Newfoundland. Land Resource Research Institute, Agriculture Canada, Ottawa, Ont. LRRI Publ. 113.

Kjearsgaard, A. A.; Peters, T. W.; Pettapiece, W. W. 1981. Soil survey of County of Newell. Alberta Soil Survey Report No. 41. Preliminary report mimeo. 200 pp. 1 map.

Kocaoglu, S. S.; Pettapiece, W. W. 1980. Soil map of Lethbridge area 82H(NE). Alberta Institute of Pedology No. M-80-3. University of Alberta, Edmonton, Alta.

MacDonald, K. B.; Strzelczyk, Z. S. 1981. The Canada Soil Information System (CanSIS) manual for describing performance/management data, 1980. Land Resource Research Institute, Research Branch, Agriculture Canada, Ottawa, Ont. Tech. Bull. LRRI 108. 120 pp.

MacDougall, J. I.; Veer, C. 1981. Soils of Prince Edward Island Preliminary report. Land Resource Research Institute, Research Branch, Agriculture Canada, Ottawa, Ont. Tech. Bull. LRRI 141.

Mapping Systems Working Group. 1981. A soil mapping system for Canada: revised. Land Resource Research Institute, Agriculture Canada, Ottawa, Ont. Tech. Bull. LRRI 42. 94 pp.

McKeague, J. A. 1981. Organo-mineral migration; some examples and anomalies in Canadian soils. Pages 341-348 *in* Migrations organo-minérales dans les sols tempérés. Coll. Int. Nancy, France (Sept. 1979). C.N.R.S., Paris.

McNeely, R. N.; Neimanis, V. P.; Dwyer, L. M. 1979. Water quality sourcebook—A guide to water quality parameters. Water Quality Branch, Inland Waters Directorate, Environment Canada, Ottawa, Ont.

Peters, T. W. 1981. Reconnaissance soil survey of the Brazeau Dam area (83B-NW and portion of 83G-SW). Alberta Institute of Pedology, University of Alberta. Alberta Soil Survey Report No. 40. 75 pp., 1 map.

Peters, T. W. 1981. Solonetzic soils of Alberta. Map at 1:1 million. University of Alberta, Edmonton, Alta. Alberta Institute of Pedology No. M-80-4.

Peters, T. W.; Pettapiece, W. W. 1981. Crop yield in Alberta: preliminary relationships to soil capability for agriculture and soil type. University of Alberta, Edmonton, Alta. Alberta Institute of Pedology No. M-81-1. 83 pp.

Pettapiece, W. W.; Lindsay, J. D. 1981. Soil resources and agricultural capability in northwestern Canada. Agric. For. Bull. 4(1):3-10.

Reid, W. S.; Desjardins, R. L.; Buckley, D. J.; Fagan, W. 1981. Air bearings in a wing-vane propeller anemometer. Engineering and Statistical Research Institute, Agriculture Canada, Ottawa, Ont. Tech Bull. 1-290. 25 pp.

Rostad, H. P. W. 1981. Acid soils in west central Saskatchewan. A map. Saskatchewan Institute of Pedology Publ. M64.

Schewchuk, S. R.; Abouguendia, Z. M.; Atton, F. M.; Dublin, J.; Godwin, R. C.; Holowaychuk, N.; Hopkinson, R.; Liaw, W. K.; Maybank, J.; Padbury, G. A.; Schreiner, B. T. 1981. Transport and potential effects of acid deposition in northeastern Alberta and northern Saskatchewan: A problem analysis. Saskatchewan Research Council Publ. No. P-780-1-B-81. 124 pp.

Steffensen, R.; Shields, J. A.; Goodfellow, L. C.; Mack, A. R. 1981. A procedure to overlay thematic map and dominion land survey system data to geometrically-corrected Landsat images and its application to agricultural land use studies in Western Canada. Proc. 7th Can. Symp. Remote Sensing, Winnipeg, Man. 10 pp.

Tarnocai, C.; Veldhuis, H. Soils of the Firth–Horton Rivers map area, Northwest Territories. Land Resource Research Institute, Agriculture Canada, Ottawa, Ont.

Topp, G. C.; Davis, J. L.; Annan, A. P. 1980. Electromagnetic determination of soil water content: Application of TDR to field measurements. Pages 176-181 *in* Proc. 3rd Coll. Planetary Water. Department of Geology, State University of New York, Buffalo, N.Y.

Wang, C.; Coote, R. 1981. Sensitivity classification of agricultural land to long term acid precipitation in Eastern Canada/Classes de sensibilité des terres agricoles à l'action prolongée des précipitations acides dans l'est du Canada. Research Branch/Direction générale de la recherche, Agriculture Canada, Ottawa, Ont. 9/12 pp.

Research Program Service

Ottawa, Ontario

PROFESSIONAL STAFF

Administration

R. Trottier, B.Sc., M.Sc., Ph.D.	Director
D. W. Friel	Administration and awards
W. A. Fettes	Branch liaison

Graphics

C. N. Halchuk	Art and design
W. G. Wilson[1]	Photography
G. Bourgon	Acting, Photography

Scientific Editing/Text Processing

J. A. Perrin,[2] B.Sc.	Head of Section
D. M. Archibald, B.A.	Acting Head of Section
S. V. Balchin	Editing
M. M. Ellis	Text processing
N. Rousseau, B.A., M.A.	Editing
S. M. Rudnitski, B.Sc.	Editing
F. Smith, B.A.	Editing
A. Thomasin, B.A., B.A. (Geog.)	Editing
J. M. Tomlinson, B.A., M.A.	Editing

Scientific Information Retrieval

J. TAKY,[3] B.A., B.Sc.	Head of Section
P. BEAUCHAMP, B.Sc., M.Sc.	Herbicides
J. S. KELLEHER, B.Sc., M.Sc., Ph.D.	Biological control
H. S. KREHM,[4] B.A., M.A., Ph.D.	Fungicides and insecticides
C. D. LAING, B.Sc., M.Sc.	Inventory
D. PRESLEY	Systems

---

[3]On Official Language Training, 4 August 1981–.
[4]Seconded to the Management Accountability Directorate, 13 July 1981–.
[3]Appointed 27 July 1981.
[4]Seconded to Information Services, Pesticides, 15 June 1981–.

INTRODUCTION

Research Program Service supports research and development in the Branch by maintaining computerized scientific and technical information systems, providing publications services, and administering Branch awards and liaison. The Service is divided into four sections: Administration, which contains the Awards and Branch Liaison units; Graphics, which contains the Art and Design and the Photography units; Scientific Editing/Text Processing, which contains English and French Editing units, as well as the Text-Processing Unit; and Scientific Information Retrieval, which contains the Biocontrol, Systems, Pesticides, and Inventory units.

The Scientific Information Retrieval Section developed phase 1 of the national computerized Pesticide Research Information System (PRIS) in July and demonstrated it in Winnipeg, Ottawa, and Drummondville by year's end. The Section also published the 1981 *Pesticide Research Report* and four issues of the newsletter *Pesticide Information*.

The Graphics Section and the Scientific Editing/Text Processing Section set production standards this year, specifying the quality needed in various types of Branch publications. These standards, which have since been approved by the Branch Management Committee, should increase cost effectiveness in the Service. *Manual of Nearctic Diptera, Volume 1*, which was published early in the year, was awarded first prize for editing at the 1981 Canadian Technical Art and Technical Publications Competition, a national event sponsored by the Eastern Ontario Chapter of the Society for Technical Communication. The publication also received an Award of Achievement in the International competition sponsored by the American branch of the Society. Other significant publications issued during 1981 include *Trees and Shrubs of the Dominion Arboretum*, *Champignons comestibles et vénéneux du Canada*, and *Food from Land/De la terre à la table*.

The Awards and Branch Liaison units of the Administration Section continued to administer the programs for operating grants, extramural research grants, and visiting fellowships and to coordinate international scientific visits and the Canada–France exchange program. News of happenings in the Research Branch was circulated to all staff members in nine issues of *Tableau*.

Further information can be obtained from the Director, Research Program Service, Research Branch, Agriculture Canada, Ottawa, Ont. K1A 0C6.

R. Trottier
Director

AWARDS AND BRANCH LIAISON

Research Program Service continued to administer the extramural research grants, operating grants, visiting fellowships, and scientific exchange programs during 1981.

Under the extramural research grants program, specific research projects are solicited from university scientists to augment current research programs. The program is the responsibility of a Departmental committee appointed by the Deputy Minister. In 1981, a total of 72 applications were received.

Operating grants are awarded to individual researchers at Canadian universities as contributions toward the costs of proposed research projects that will be of value to the agricultural industry. The selection committee consists of three representatives from Agriculture Canada and seven from faculties of agriculture and veterinary science. In 1981, the committee received 277 applications.

The visiting fellowships program gives promising young scientists, from all over the world, the opportunity to work with distinguished researchers in their respective fields before embarking on careers in scientific research. The program is administered by the Natural Sciences and Engineering Research Council on behalf of Canadian government departments and agencies. Research Program Service acts as liaison between the Council and Agriculture Canada. In 1981, there were

200 applications for fellowships in this Department.

The Branch Liaison Unit arranged for 27 delegations to visit Branch establishments during the past year: ten from France, three from the People's Republic of China, two each from Hungary and Mexico, and one each from Australia, Brazil, Columbia, Egypt, Indonesia, Israel, Sweden, the United Kingdom, the USSR, and Zaire. The Unit also made arrangements for 16 delegations from Canada: three to the People's Republic of China, two each to Mexico and Brazil, and one each to Argentina, Cuba, Japan, Lagos, Spain, Turkey, Upper Volta, Venezuela, and the USSR. Nine issues of *Tableau* were published this year.

GRAPHICS

A wide variety of services in research photography and production art and illustration were provided to the Branch and other agencies within the Department.

Standards for cover designs, preparation of camera-ready texts for printing, and graphic-production turn-around time were established this year. They were presented to and approved by the Branch Management Committee in November. These standards are to be detailed in a revision of *ABC Guidelines to Manuscript Preparation*. The turn-around time for graphics arts and photographic services was reduced to 8.5 days in 1981 from 13 days in 1980. The production standards call for an average turn-around time of 11 days for graphics services and 3 mo for typescripts submitted in camera-ready format.

An in-house computerized management system, which was developed in 1980 by the Scientific Information Retrieval Section, was implemented in the Graphics Section in 1981. Monthly production records were thereby monitored to determine and improve production efficiency. Production in the Section was found to have increased by 12% over last year, with the completion of 1977 jobs in 1981 compared with 1763 jobs in 1980. This figure includes 122 manuscripts received in camera-ready form, for which the Section provided a printing service. Quality and accuracy of art and photographic services were maintained at last year's level, with the number of jobs returned for correction remaining at less than 1%.

SCIENTIFIC EDITING/TEXT PROCESSING

The editorial and text-processing services provided by the Section continued to help improve the technology transfer facility of the Branch in 1981.

New word-processing equipment was acquired this year in the Text Processing Unit. The new Wang installation includes a central processing unit, a disc drive, a supervisory screen and three work stations, one dual-head character printer, one single-head character printer, an optical character reader (OCR), and an OCR interface to the Wang system.

Publication standards, to be applied according to the size and needs of the target audience, were established in the Section in 1981 for covers, title pages, text and figure layouts, scientific editing, and the use and coordination of the Wang installation within the Branch for various types of publications. These recommendations were presented to and approved by the Branch Management Committee in November and are to be detailed in a revision of *ABC Guidelines to Manuscript Preparation*. The production standards specify that camera-ready typescripts requiring a copy edit are to be published in 4 mo; camera-ready typescripts requiring a copy edit and translation into one of the official languages are to be published in 6 mo; and manuscripts requiring a full edit, translation, typesetting, and printing are to be published in 11 mo. These times are computed for the average manuscript of 50–100 pages and are adjusted when the manuscript deviates from the average length.

An in-house computerized management system developed this year by the Scientific Information Retrieval Section was implemented in the Scientific Editing/Text Processing Section to monitor monthly progress in the editing and production of publications. This management tool is intended to facilitate the scheduling of all manuscripts processed by the Section, thereby improving production efficiency. Schedules were established for each manuscript in 1981 and were met more than 90% of the time. Both of the annually published Branch publications met their objective this year in that they were written, edited, typeset, and printed within the following calendar year. *Progress in Research 1980* came out 5 mo earlier than did the 1979 report, and *Research Branch Report*

1980, 1 mo earlier than it did the previous year.

Although efficiency has been increased by 10% this year with the publication of 62 manuscripts and with 63 others in various stages of production, the quality of our publications has remained high. *Manual of Nearctic Diptera, Volume 1*, which was published early in the year, was awarded first prize for editing in the 1981 Canadian Technical Art and Technical Publications Competition, a national event sponsored by the Eastern Ontario Chapter of the Society for Technical Communication. From a field of about 400 regional winners, the book was also among the 60 or so entries to receive International recognition by the American branch of the Society, with an Award of Achievement. Many other publications have also been well received, as judged from the frequency with which they have been reprinted, the sales volumes, and the many letters of appreciation received by the Service. A few of the significant publications released this year are listed below:

- *Trees and Shrubs of the Dominion Arboretum*
- *Food from Land/De la terre à la table*
- *Champignons comestibles et vénéneux du Canada*
- *Regina Research Station 1931–1981*
- *Research Institutes: Programs and Services/Instituts de recherche: programmes et services*
- *Fougères du district d'Ottawa*
- *Cueillette et montage de spécimens botanique*
- *Nutritional Muscular Dystrophy of Young Ruminants*
- *Diseases of Carrots in Canada*
- *Sensitivity Classification of Agricultural Land to Long-term Acid Precipitation in Eastern Canada*
- *Classes de sensibilité des terres agricoles à l'action prolongée des précipitations acides dans l'est du Canada*

SCIENTIFIC INFORMATION RETRIEVAL

Phase 1 of the Pesticide Research Information System (PRIS) was made available online across Canada in October. Three of the six projected components of the system were demonstrated by the year's end and provide instant information access on Datacrown to researchers in the field, whatever their affiliation. Data available relate to approved experimental pesticides, to some pesticides currently registered for use in Canada, and to research being conducted on pesticides in Canada.

In addition, the Section continued to maintain a computerized storage and retrieval system on agricultural research in Canada, the Inventory of Canadian Agricultural Research (ICAR). The information is available to researchers; funding agencies; provincial, regional, and national research planning and coordinating committees; and anyone else interested in agricultural research. Requests for information in 1981 were answered in less than 10 working days. A hard copy of this information was also made available. In 1981 the update process for ICAR was simplified by developing one form for both input and update that can be keypunched directly and by developing a continuous update system in collaboration with ICAR committee members.

Commonwealth Institute of Biological Control contracts were coordinated and managed for Agriculture Canada and the Canadian Forestry Service. In 1981, 22 shipments were received from seven countries for a total of 15 082 specimens. The Section sent 36 shipments to various research establishments; 14 parasite species totaling 16 097 insects were sent to seven provinces for release or study, or both.

The *Pesticide Research Report* under the auspices of the Expert Committee on Pesticide Use in Agriculture, four issues of the *Pesticide Information* newsletter, two issues of the *Canadian Plant Disease Survey*, and the *Canadian Agricultural Insect Pest Review* (1980) were produced during 1981; as well 3 yr of material on *Insect Liberations in Canada* (1978, 1979, 1980) was coordinated.

Two in-house computerized management systems were developed or implemented in 1981 in Research Program Service. One is used for publication production control and another for monitoring graphics services.

The Section also provided the Research Branch input to the Telidon Grassroots project in Manitoba. This input was made in response to the department's commitment to support the demonstration of this new system as a tool for rapid technology transfer.

PUBLICATIONS

Miscellaneous

Kelleher, J. S., compiler. 1981. The Canadian agricultural insect pest review. Vol. 58 (1980). Research Program Service, Research Branch, Agriculture Canada. 81 pp.

Krehm, H., ed. 1981. Canadian plant disease survey. Research Program Service, Research Branch, Agriculture Canada. Vol. 61, Nos. 1-2.

Taky, J., ed. 1981. Pesticide information. Research Program Service, Research Branch, Agriculture Canada. Vol. 3, Nos. 3-4.

Trottier, R., ed. 1981. Pesticide information. Research Program Service, Research Branch, Agriculture Canada. Vol. 3, Nos. 1-2.

Williamson, G. D. 1981. Insect liberations in Canada: parasites and predators (1977, 1978, 1979). Research Program Service, Research Branch, Agriculture Canada. Liberations Bull. Nos. 41, 42, 43, 44.

ATLANTIC REGION
RÉGION DE L'ATLANTIQUE

Dr. E. E. Lister

Dr. W. B. Collins

Mrs. S. M. Bowes

EXECUTIVE OF THE ATLANTIC REGION
L'EXÉCUTIF DE LA RÉGION DE L'ATLANTIQUE

Director General
Directeur général
E. E. LISTER, B.Sc., M.Sc., Ph.D.

Program Specialist
Spécialiste en programmes
W. B. COLLINS, B.Sc. (Agr.), M.Sc., Ph.D.

Regional Administration Coordinator
Coordonnateur de l'administration régionale
S. M. BOWES

PREFACE

The Atlantic Region, with headquarters in Halifax, consists of four research stations, two experimental farms, and two substations. These research establishments serve the agricultural communities in New Brunswick, Prince Edward Island, Nova Scotia, and Newfoundland. In 1981, the Region managed a budget of $15 million and employed 88 professionals to carry out its various programs.

The new Kentville Agricultural Centre was officially opened during the year, as was a new provincial wing at the St. John's Research Station. All stations in the region now house both federal and provincial personnel. This arrangement promotes cooperative approaches to solving agricultural problems in the region. The construction of a new office–laboratory building was substantially completed at the Hervé J. Michaud Experimental Farm in 1981.

In animal science, research on the identification and evaluation of opportunity feeds for beef production showed that the digestibility of poplar fermented by white rot fungi is equivalent to that of medium-quality timothy hay. Calves fed fermented colostrum are not more subject to amino acid deficiencies than those fed fresh colostrum, because fermentation was shown not to affect the absolute proportions of the various amino acids. A significant gain in poultry production efficiency was obtained by using semi-dwarf maternal genotypes, and an additional bonus is increased population density. A positive relationship between feed texture (pellets) and the incidence of acute death syndrome has been confirmed.

Advances in cereal research included the release of four superior new cultivars, Milton spring wheat, Valour winter wheat, Shaw oats, and Srebrne rye. These new cultivars will strengthen the region's potential for increased feed grain production. Fungicidal treatment of wheat seed was found to improve seedling performance significantly by reducing the pathogenicity of *Fusarium* spp., and field-scale fungicide applications increased average yields significantly. Furthermore, minimum-tillage practices can be used for wheat production without jeopardizing productivity.

In forage crops research, the development and application of sod-seeding techniques were shown to reduce energy expenditures in the management of pasture and hay land. Thus, legumes can be reseeded into a grass sward without the high costs of complete pasture renovation. Adaptable ryegrass cultivars have been identified for pasture and soil conservation in the region.

In horticultural research significant advances were achieved in seed potato production management techniques, particularly in studies of top desiccation, production of small whole seed, and identification and control of diseases and insect vectors. Two new potato cultivars were licensed, Anson and Acadia Russet. Kent strawberry and Blomidon lowbush blueberry cultivars were also released.

Developments in processing research were highlighted by successful commercial trials of the K3 blancher in France and the United States. The potential energy savings identified earlier were realized, along with improved operational functionality and ease of clean-up.

In stored-products research the low-oxygen technology was transferred successfully to commercial operators in Ontario, New Brunswick, and Nova Scotia. Premium prices were obtained on fruit from these storages. Controlled-atmosphere studies were initiated on cole crops. A prototype air washer for high-humidity, low-temperature storage of fresh produce was designed and installed cooperatively with the Engineering and Statistical Research Institute.

Significant staff changes in 1981 included the appointment of Mr. J. M. Wauthy as Superintendent of the Hervé J. Michaud Experimental Farm and of Mrs. Susan M. Bowes as Regional Administration Coordinator. Mr. Chesley Lockhart was appointed Acting Officer in Charge, Nappan Experimental Farm, while Mr. Frank Calder was on a CIDA assignment in Sri Lanka.

Further information about our programs may be obtained by writing to the research establishment concerned or by addressing inquiries to Atlantic Region Headquarters, Research Branch, Agriculture Canada, 1888 Brunswick Street, Halifax, N.S. B3J 3J8.

E. E. Lister

PRÉFACE

La région de l'Atlantique dont l'administration centrale est située à Halifax, comporte quatre stations de recherche, deux fermes expérimentales et deux sous-stations qui desservent les collectivités agricoles du Nouveau-Brunswick, de l'Île-du-Prince-Édouard, de la Nouvelle-Écosse et de Terre-Neuve. En 1981, la région disposait d'un budget de 15 millions de dollars et d'un personnel de 88 professionnels.

Le nouveau Centre agricole de Kentville ainsi que le pavillon provincial de la station de recherche de Saint-Jean (T.-N.) ont été officiellement inaugurés au cours de cette année. Toutes les stations de la région abritent maintenant sous un même toit les employés des deux paliers de gouvernement, solution qui favorise la collaboration dans l'étude des problèmes agricoles de la région. La construction d'un nouvel immeuble laboratoire-bureau a été achevée en 1981, à la ferme expérimentale Hervé J. Michaud.

La recherche zootechnique sur l'identification et l'évaluation d'aliments d'appoint pour la production du boeuf a montré que la digestibilité du bois de peuplier fermenté par les champignons de la pourriture blanche est équivalente à celle d'un foin de fléole de qualité moyenne. Les veaux nourris au colostrum fermenté ne sont pas plus sujets aux carences en acides aminés que ceux nourris au colostrum frais, car le procédé de fermentation ne semble pas modifier les proportions absolues des divers acides aminés. Par l'utilisation de génotypes maternels semi-nains, il a été possible d'améliorer sensiblement la production avicole ainsi que d'accroître la densité de population. On a, en outre, pu confirmer la relation positive qui existe entre la texture des aliments (comprimés) et l'apparition du syndrome de la mort subite.

Dans le domaine des céréales, il faut noter la mise sur le marché de quatre nouveaux cultivars de qualité supérieure, le blé de printemps Milton, le blé d'hiver Valour, l'avoine Shaw et le seigle Srebrne, qui renforceront les potentialités de production de céréales fourragères dans la région. Les traitements fongicides des semences de blé améliorent d'une façon sensible le comportement au départ, en réduisant l'effet pathogène des *Fusarium* spp., et les apports de fongicide en grande surface accroissent sensiblement le rendement moyen du blé. En outre, les pratiques de culture sans labour peuvent être utilisées dans la production du blé sans pour autant compromettre la productivité.

Du côté des cultures fourragères, on a pu constater que l'application de nouvelles techniques de semis direct sous gazon réduisent les dépenses en énergie liées à la gestion des prairies et des pâturages. Les légumineuses peuvent donc être ressemées dans un gazon établi, sans qu'on ait à défrayer les coûts élevés d'une régénération complète du pâturage. Certains cultivars de ray-grass se sont montrés utiles comme plantes de pâturage et comme moyen de conservation des sols. La recherche horticole a réalisé des progrès significatifs dans les techniques de culture des pommes de terre de semence, particulièrement en ce qui concerne le défanage, la production de petits tubercules de semence (à planter entiers) l'identification des maladies de la pomme de terre, de leurs insectes vecteurs et des moyens de les combattre. Deux nouveaux cultivars de pomme de terre, l'Anson et l'Acadia Russet, ont été homologués. Deux cultivars de petits fruits ont été lancés sur le marché: la fraise Kent et le bleuet nain Blomidon.

Les travaux dans le domaine de l'industrie alimentaire ont été soulignés par le succès des essais commerciaux du blancheur K3 en France et aux États-Unis. L'économie d'énergie déjà constatée auparavant s'est concrétisée et le matériel a démontré ses qualités fonctionnelles et sa facilité de nettoyage.

En ce qui concerne la conservation des produits, la technologie de conservation en atmosphère à basse concentration en oxygène a été transmise avec succès aux opérations commerciales de l'Ontario, du Nouveau-Brunswick et de la Nouvelle-Écosse. On a obtenu des prix supérieurs pour les fruits conservés selon ces méthodes. On a entrepris des études en atmosphère contrôlée sur les choux. Un prototype de dispositif d'absorption du gaz carbonique pour la conservation des produits frais en régime d'humidité élevée et de basse température a été conçu et installé en collaboration avec l'Institut de recherche technique et statistique.

Parmi les changements de personnel importants apportés en 1981, on note la nomination de J.M. Wauthy au poste de régisseur de la ferme expérimentale Hervé J. Michaud et de Susan M. Bowes à celui de coordonnatrice de l'administration régionale. Chesley Lockhart a été nommé directeur intérimaire de la ferme expérimentale de Nappan pendant l'absence de Frank Calder en mission au Sri Lanka avec l'ACDI.

Pour obtenir de plus amples renseignements sur nos programmes, vous êtes prié de vous adresser aux établissements de recherche ou à l'Administration centrale de la région de l'Atlantique, Direction générale de la recherche, Agriculture Canada, 1888 rue Brunswick, Halifax, N.-É. B3J 3J8.

E.E. Lister

Research Station
St. John's West, Newfoundland

PROFESSIONAL STAFF

H. W. R. Chancey, B.S.A., M.S.A.	Director

Entomology

R. F. Morris, B.S.A., M.Sc.	Head of Section; Vegetable insects

Horticulture

B. G. Penney, B.Sc., M.Sc.	Vegetable crops

Plant Breeding and Pathology

K. G. Proudfoot, B.Agr., M.Agr.	Head of Section; Potato breeding
M. C. Hampson, B.Sc., M.Sc., Ph.D.	Plant diseases

Agronomy

A. F. Rayment, B.Sc., M.Sc.	Soil fertility and drainage

INTRODUCTION

The Research Station located at St. John's West, 8 km from City Center, is responsible for agricultural research in Newfoundland and Labrador. The Station's program emphasizes research on the control of potato wart disease, clubroot disease of rutabaga, and the golden nematode, together with control of economic crop insects, plant nutrition, and vegetable adaptation trials. Increasing effort is being directed to experimental peat soil studies on vegetable and forage production, drainage and cultivation techniques, and the design and adaptation of mechanical equipment for cultivating, fertilizing, seeding, and harvesting peat soil crops.

Previous reports and reprints can be obtained from the Research Station, Research Branch, Agriculture Canada, P.O. Box 7098, St. John's West, Nfld. A1E 3Y3.

H. W. R. Chancey
Director

ENTOMOLOGY

Cabbage root maggot

Rutabagas. Field experiments with rutabagas were repeated at St. John's and Wooddale to determine if local populations of the cabbage maggot were becoming tolerant to Dasanit (fensulfothion). In both localities, split applications of Dasanit (half at seeding and half after thinning) were significantly more effective than equivalent applications applied as granules at time of seeding. Single applications of granules in both localities gave inadequate control. No resistance to Dasanit was detected, as split applications at the recommended dosage gave adequate control in both areas.

Tests conducted by the London Soil Pesticide Laboratory indicated that the St. John's strain of root maggot flies was still susceptible to both Dasanit (fensulfothion) and Furadan (carbofuran) and that the LD_{50} was in line with results obtained with a London susceptible strain.

Rutabaga varieties Purple King, Macomber, Monarch, Altasweet, Fortune, Laurentian (Standard), Laurentian (Eastern), York, and Wilhelmsburger, and summer turnip varieties Tokyo Cross, Purple Top White Globe, and American Purple Top were evaluated at this Research Station for resistance to root maggot attack. The experiment was conducted in an area of high root maggot infestation, with continuous pressure throughout the growing season. Wilhelmsburger was the most resistant rutabaga and Purple King the least. American Purple King was the most resistant summer turnip and Tokyo Cross was the most susceptible. Selected rutabaga roots have been retained for seed production in order to assess the possibility of increasing resistance through a breeding program.

Early cabbage. Five pyrethroid insecticides, Ambush (permethrin), Belmark (fenvalerate), Ripcord (cypermethrin), Decis (deltamethrin), and Cymbush (cypermethrin), at two levels of drench treatments, were evaluated for root maggot control on early cabbage. All, except Belmark and the lower concentration of Decis, gave significant control in a moderate infestation of root maggot and were equally as effective as Diazinon and Dasanit.

Blueberry leaf tier

Ten insecticide treatments and controls, replicated four times in random block design, were established at Roaches Line on 15 June 1981. Larval counts were taken on 12 June (before spraying) and on 19 and 25 June and 3 and 10 July (after spraying), by making five 180° sweeps with a butterfly net. All insecticide treatments reduced larval populations, but the decline of larval numbers in both series of control plots made evaluation of treatments difficult. Five of the pyrethroid treatments, including Belmark, Ripcord, and Decis, were as effective as Guthion in controlling the leaf tier.

Three hundred and fifty-nine larvae collected on blueberry plants from 13 communities were checked for natural parasites. Only three parasites were reared, all from 21 larvae collected on 26 June at Paddy's Pond. These

were identified as *Itoplectis quadricingulata* Provancher by the Biosystematics Research Institute, Ottawa, Ont.

PLANT SCIENCE

Field crops

Soil conditioners. Agromax NiPhoKal-1 and Agromax 17-5-5-GR were evaluated under field conditions with rutabaga (cultivar York) and cabbage (cultivar Bergkabis) grown on a gravelly clay loam soil. Both Agromax products failed to significantly affect marketable or total yields of rutabaga or cabbage.

Carrots. A trial to determine the effect of ridging on yields and root length of carrots was established on the Northern Arm peat bog. Planting on ridges produced higher yields and longer carrots than planting on unridged rows. The mean marketable yield and root length were as follows: ridged—11.6 t/ha, 19.3 cm; unridged—4.7 t/ha, 15.1 cm. Improved local drainage and greater depth of limed soil probably accounted for better production on ridged rows.

In carrot fertility trials on peat soils, all combinations of three levels (100, 200, 300 kg/ha) of N, P_2O_5, and K_2O were evaluated using the cultivar Spartan Fancy. Excessive rainfall and poor drainage prevented making any definite conclusions, but it would appear that N at 224 kg/ha might be necessary for satisfactory yields.

Blueberries

Hexazinone with active ingredient (a.i.) at 0.5 kg/ha in combination with atrazine or simazine gave good control of *Festuca capillata* (hair fescue), *Hieracium* spp. (hawkweed), *Juncus* spp. (rush), *Fragaria* spp. (strawberry), and *Achillea millefolium* (yarrow) in lowbush blueberries (*Vaccinium angustifolium*). None of the treatments controlled *Cornus canadensis* (bunchberry) or caused any visual injury to blueberry plants.

Partridgeberries

Productivity of native stands of partridgeberries (*Vaccinium vitis-idaea*)was again determined at several locations on the Avalon and Bonavista peninsulas. Mean yields in kilograms per hectare were as follows: Pouch Cove—1303; Adams Cove—1068; Riverhead, St. Mary's Bay—841; Little Catalina—775; Newman's Cove—413; and Avondale—263.

SOIL SCIENCE

Peat soils

Fertility. Established grass stands on a mature peat soil responded less by 8–15% to a 0-46-0 phosphate source compared with 0-20-0 superphosphate. It was also shown that timothy had a greater phosphorus requirement than reed canarygrass. The response curve of first-cut timothy to phosphorus (P_2O_5, kilograms per hectare) from 0-20-0 was defined by a Mitscherlich *C* value of 0.0095. In terms of the 0-46-0 source, this value would become 0.0081, compared with the estimate of 0.0078 determined in 1980.

Compared with seeding year results, the grass component of a timothy–reed canarygrass–red clover mixture decreased in molybdenum content by almost 50% in the absence of a maintenance treatment but increased slightly on application of half the initial maintenance rate. Red clover was higher in molybdenum content than the grasses were and, in general, increased in molybdenum content over initial results even in those plots receiving no maintenance treatment. Concentrations of molybdenum in clover tissue approaching the accepted toxicity threshold of 15 mg/kg were attained for a normal field treatment of molybdenum at 0.04 kg/ha, but only when in combination with a high Cu treatment.

Peat drainage. Drought conditions in early summer and excess moisture later produced unusual results in a peat drainage experiment. Best potato yields were obtained on level soil near the main drains of land improved by supplementary slit drains. This combination provided a cushion against the extreme drought conditions but at the same time provided improved drainage for the wet part of the season. Ridging was beneficial to both potatoes and carrots on land that was not treated with supplementary ditches, but under the particular seasonal conditions, failed to be a substitute for the latter. It is probable that irrigation would be required for best crop production where such moisture extremes occur in a single season. Supplemental slit drains were particularly effective during the latter part of the season, when they lowered water tables from a mean of 33.3 cm below

the surface of untreated areas to 54.6 cm below the surface for treated areas.

Machinery. The peat drainage ditcher designed at Memorial University of Newfoundland (MUN) was modified to move the center of gravity forward and thus provide balance when in the travel position. Further minor modifications included changes in the hydraulic system to minimize fluid heating and the installation of spoil deflection guides. Production-scale ditching of about 1200 m was completed at the end of the season.

The MUN-designed carrot harvester was field tested on a very wet peat at Colinet and on firmer, more fibrous material at Northern Arm. Though the soft conditions at Colinet favored uprooting of carrots through tension on the tops, at neither site could this be relied on as the sole harvesting aid. The addition of loosening shears to the harvesting head has been recommended, prior to further field tests.

PLANT BREEDING AND PATHOLOGY

Infectivity and germination in potato wart disease

Infested soil was treated with NH_4NO_3, urea, $CaCO_3$, $NaNO_3$, KNO_3, $NH_4H_2PO_4$, $(NH_4)SO_4$, or NH_4Cl; then potato cultivar Arran Victory tubers susceptible to wart race 2 were planted in the amended soils. Infection was greatest with NH_4NO_3 and least with lime. This confirms previous field-work findings. In parallel greenhouse work, water was amended with the above chemicals. Little or no infection resulted from inoculating tubers by immersing them in the solutions together with tumor excrescences. This suggests the chemicals inhibit infection directly but influence indirectly through stimulation of soil factors. Two experiments with plants under stress gave results that suggested that the role of the plant in infection was not dominant. One group of plants was grown in wart-infested soil with earthworms; another group was grown in a controlled environment room under different water stresses. Although plant growth was stimulated and inhibited, respectively, production of tumor tissue remained level except when the host was under severe stress.

The sporangial wall of the wart fungus was found to contain considerable chitinous material set in a proteinaceous matrix. Chitin appears to be actively metabolized at the interface of fungus and host, and chemical analysis of the sporangial wall showed the presence of 22 ninhydrin-positive substances. A method was devised to separate sporangia from host tissue using sucrose centrifugation. The ensuing sporangial population is rendered debris-free and suitable for electron microscopy and chemical analysis.

Breeding potatoes for resistance to wart and golden nematode

Evaluation of the wart-resistant selection N135-671 was completed and the cultivar has been licensed under the name Anson. As reported in previous trials, this cultivar is high yielding with maturity and has a dry matter content similar to Green Mountain. It also possesses high resistance to late blight and virus infection.

Selections N664-127 (wart and nematode resistant) and N647-24 (blue-skinned, wart resistant) were included in growers' trials and the results reported have been favorable. Anson, Mirton Pearl, and N664-127 cultivars were successfully crossed with Cambridge and Peruvian material to combine resistance to wart and both species of potato cyst nematodes. Eighty-six F-78 selections from the National breeding program were checked for resistance to wart disease. Only five of these selections were free from wart infection.

Breeding clubroot-resistant rutabaga

Rutabaga × summer turnip (RST) seed was distributed to several growers who reported excellent crops of clubroot-free roots. Selected roots from Research Station plots have been retained for breeder seed production.

Both Fortune and RST lines developed at this Station show good resistance to storage rot (*Erwinia* sp.). Roots from the RST source have been used in a crossing program aimed at developing a wide-based population that will be resistant to both bacterial soft rot and clubroot.

A replicated field trial of 12 cultivars of rutabaga and summer turnip was established to evaluate susceptibility to root maggot damage. Observation plots of 40 cultivars and breeding lines were also set out for the same purpose. The cultivars York, Laurentian, and

Fortune were most susceptible, with Wilhelmsburger the least. A number of green-topped entries showed less damage than purple-topped.

PUBLICATIONS

Research

Bal, A. K.; Murphy, A. M.; Hampson, M. C. 1981. Ultra-structure and chemical analysis of the resting sporangium wall of *Synchytrium endobioticum*. Can. J. Plant Pathol. 3:86-89.

Hampson, M. C. 1981. Potato wart caused by *Synchytrium endobioticum*: Past and future emphases in research. Can. J. Plant Pathol. 3:65-72.

Morris, R. F. 1981. Note on the occurrence of the lubber grasshopper, *Brachystola magna* (Orthoptera: Romaleidae), in Newfoundland. Can. Entomol. 113:659-660.

Rayment, A. F.; Campbell, J. A. 1980. The influence of different drainage techniques on water outflow, soil aeration and crop grown on a Newfoundland peat soil. Proc. 6th Int. Peat Congr., Duluth. pp. 451-454.

Rayment, A. F.; Robb, A. D.; Bradshaw, G. G. 1980. Development of a rotoridger–seeder to form and seed raised beds for vegetable production on a Newfoundland peat soil. Proc. 6th Int. Peat Congr., Duluth. pp. 455-459.

Miscellaneous

Campbell, J. A.; Millette, J. A.; Rayment, F.; Frascarelli, L. 1981. Oxygen limits crop growth in organic soils. Can. Agric. 26(2):21-22.

Hampson, M. C. 1981. Agricultural pests—diseases. *In* J. R. Smallwood and R. D. W. Pitt, eds. Encyclopedia of Newfoundland and Labrador. pp. 9-10.

Hampson, M. C. 1981. Infection of additional hosts of *Synchytrium endobioticum*, the causal agent of potato wart disease: 3. Tomato as an assay tool in potato wart disease. Can. Plant Dis. Surv. 61:15-18.

Hampson, M. C. 1981. Phomopsis canker on weeping fig in Newfoundland. Can. Plant Dis. Surv. 61:3-5.

Hampson, M. C. 1981. Potato sprouts and potato wart disease. Can. Agric. 26(3):30-31.

Hampson, M. C. 1981. Wart. Pages 36-37 *in* W. J. Hooker, ed. Compendium of potato diseases. Am. Phytopathol. Soc., St. Paul, Minn.

Morris, R. F.; Morry, H. G. 1980. Vegetable, field crop and other injurious insect pests predominating in Newfoundland. Can. Agric. Insect Pest Rev. 58:12, 23, 25, 37, 41-42, 47-48, 54, 57-59.

Research Station

Charlottetown, Prince Edward Island

PROFESSIONAL STAFF

L. B. MacLeod, B.Sc. (Agr.), M.Sc., Ph.D., F.C.S.S.S.	Director
C. B. Willis, B.Sc. (Agr.), Ph.D.	Assistant Director
D. A. Hutchinson	Administrative Officer
B. Stanfield,[1] B.S.A., M.S.A., M.L.S.	Librarian

Forage and Livestock

L. S. Thompson, B.Sc. (Agr.), Ph.D.	Head of Section; Insects—forage, cereal, and potato
T. M. Choo, B.Sc., Ph.D.	Red clover breeding
H. T. Kunelius, B.Sc., M.Sc., Ph.D.	Physiology and management—forage
P. R. Narasimhalu, B.Sc., B.V.Sc., M.S., Ph.D.	Quality and utilization—forage
M. Suzuki, B.Sc., Ph.D.	Biochemistry and physiology—forage
C. B. Willis, B.Sc. (Agr.), Ph.D.	Forage diseases
K. A. Winter, B.Sc. (Agr.), M.Sc., Ph.D.	Cattle nutrition

Cereals

J. A. MacLeod, B.Sc. (Agr.), M.Sc., Ph.D.	Head of Section; Nutrition—forage and cereal
A. J. Campbell, B.Eng.	Agricultural engineering
U. C. Gupta, B.Sc. (Agr.), M.Sc. (Agr.), Ph.D., F.C.S.S.S., F.A.S.A., F.S.S.S.A.	Micronutrients—soil and plant
H. W. Johnston, B.Sc. (Agr.), M.Sc., Ph.D.	Cereal diseases
R. A. Martin, B.Sc., B.Sc. (Agr.), M.Sc., Ph.D.	Cereal diseases
H. G. Nass, B.S.A., M.Sc., Ph.D.	Wheat breeding, cereal physiology
J. D. E. Sterling, B.S.A., M.Sc.	Barley breeding
R. P. White, B.S. (Ed.), M.S., Ph.D.	Nutrition and management—corn and potato, soil chemistry

Horticulture and Tobacco

J. A. CUTCLIFFE, B.Sc. (Agr.), M.Sc.	Head of Section; Nutrition and management—vegetable
J. A. IVANY, B.Sc. (Agr.), M.S., Ph.D.	Weed control—vegetable, potato, and cereal
J. KIMPINSKI, B.S.A., M.Sc., Ph.D.	Nematology
J. G. MCDONALD, B.Sc. (Agr.), M.Sc., Ph.D.	Potato virus diseases
H. W. PLATT, B.Sc., Ph.D.	Potato diseases
D. C. READ, B.Sc. (Agr.), M.Sc., Ph.D.	Pesticide bioactivity, vegetable insects
J. M. SADLER, B.Sc., M.Sc., Ph.D.	Soil management
J. B. SANDERSON, B.Sc. (Agr.), M.Sc.	Management and nutrition—potato

Departures

S. R. KNIGHT, B.Sc. Resigned November 1981	Information Officer
J. H. LOVERING, B.Sc., M.A., Ph.D. Transferred to Regional Development and International Affairs Branch, February 1981	Production economics
J. A. MCISAAC, B.Sc. Transferred to Regional Development and International Affairs Branch May 1981	Systems engineering

VISITING SCIENTIST

A. V. STURZ, B.Sc., Ph.D. Natural Sciences and Engineering Research Council Visiting Fellow	Cereal diseases

[1]Seconded from Libraries Division, Finance and Administration Branch.

INTRODUCTION

The Research Station at Charlottetown has Atlantic Region responsibility for research on the production and utilization of livestock feed crops (forages, cereals, protein crops), tobacco, and certain vegetable crops (cole crops, peas) grown for processing. Emphasis on potato research is in the areas of nutrition and management for processing and table potatoes, but especially for small whole-seed potato production. Research is also conducted on disease evaluation and control and postharvest testing by enzyme-linked immunosorbent assay (ELISA) for virus content of potatoes destined for the domestic and export seed markets.

Ten technology transfer projects were conducted cooperatively with 29 producers to introduce and implement new crops and technology to the industry.

Dr. A. V. Sturz, a postdoctoral fellow, came to the Station during 1981 to conduct research on the epidemiology of *Fusarium* diseases of cereals with the Station's cereal pathologists.

During the year, a Charlottetown scientist, Dr. Umesh C. Gupta, was honored with fellowships in the American Society of Agronomy and the Soil Science Society of America.

This report includes brief summaries of some of the research completed in 1981. More detailed information may be obtained by referring to the Station's *Research Summary*, which is published annually, or by contacting the Research Station, Research Branch, Agriculture Canada, P.O. Box 1210, Charlottetown, P.E.I. C1A 7M8.

L. B. MacLeod
Director

CEREAL AND PROTEIN CROPS

Breeding and testing

Barley. The two-row lines AB53-4, AB53-8, and AB59-10 from the Charlottetown Research Station; TB79-02 from Thompson Seeds, Ontario; and the two-row variety Gitane from France all showed considerable promise on the basis of trials conducted since 1979. Of the licensed barley varieties, Bruce has demonstrated a superior combination of productivity, resistance to lodging, and tolerance to diseases now prevalent in the Maritime Provinces.

Oats. Shaw, a new high-yielding variety with low hull percentage and good resistance to lodging, was licensed. It is particularly suited to the Maritime Provinces and was developed jointly by the research stations at Sainte-Foy and Charlottetown.

Spring wheat. The new spring wheat variety Milton, previously called AW 4, was released for the Maritime–Quebec Region through SeCan. Milton is an awned, hard red feed wheat with resistance to *Erisyphe graminis* DC. ex Merat f. Sp. *tritici* Marchal.

Four selection methods—visual head selection by three selectors, head weight, harvest index, and random selection—were evaluated for selecting high-yielding plants in two F_2 populations of spring wheat. Forty F_2 lines of each of the crosses for each selection method were evaluated in 2 yr for grain yield in F_4. Considering mean grain yield, random selection was slightly less effective than the other three methods in selecting high-yielding lines. Visual head selection produced many late-heading, tall plants. Harvest index tended toward the selection of lines with short height. On the basis of obtaining the top 15% of F_4 lines in the two crosses, two selectors chose the greatest number of superior lines in the high-yielding cross, but in the low-yielding cross all selection methods produced a similar number of superior lines. Visual head selection was the most efficient method for selecting superior lines.

An investigation of the nature of combining ability governing harvest index and grain yield was conducted in a six-parent diallel of spring wheat. General combining ability effects were of major importance for grain yield and harvest index, whereas specific combining ability effects were of little consequence. Grain yield and harvest index were correlated with each other and highly controlled by additive gene action. Harvest index measurements are of considerable value in the development of high-yielding spring wheat varieties for the Maritime Provinces.

Winter wheat. The variety Valor was released jointly with the Ottawa Research Station for production in the Maritime Provinces. Valor is a medium-hard, red winter wheat suitable mainly for feeding livestock. It has higher yield, higher test weight, higher 1000-kernel weight, greater winter survival, and greater resistance to *E. graminis* than Lennox, the principal variety of the area. However, it has slightly weaker straw and slightly lower grain protein than Lennox. Valor was released through SeCan for the purpose of offering cereal producers another variety to choose from rather than as a replacement for Lennox.

Doubled haploids

Genetic theories. An F_2-derived, doubled-haploid population can provide estimates of additive and additive × additive genetic variances. With its parents it can also provide an estimate of average recombination value in the absence of additive epistasis. If additive epistasis is present, the average recombination value can be estimated from either doubled-haploid populations derived from backcrosses of the F_1-families and doubled-haploid populations derived from a set of diallel crosses; the variance of recombination values can be studied in the latter plant material also. In the presence of linkage, the F_2-derived doubled-haploid population may contain almost 50% more of the best recombinant than does the F_1-derived population.

Gene interaction. Gene interaction can be detected by studying the skewness and kurtosis of a biparental doubled-haploid population. The two cumulants were studied in four doubled-haploid populations of barley. Results suggested that complementary gene interaction was present for heading date in one population and duplicate gene interaction was present for plant height in another.

Number of genes. The number of segregating genes was estimated in four crosses of barley. Results showed that the number of segregating genes for grain yield, heading date, and plant height ranged from 5 to 11, 6 to 9, and 4 to 13, respectively.

Breeding methods. Results of a comparative study showed that the frequency distribution of doubled-haploid lines was the same as that of single-seed descent lines with respect to grain yield, heading date, and plant height in two crosses of barley. This indicates that both doubled-haploid and single-seed descent methods are equally efficient for use in deriving homozygous lines from F_1 hybrids in a relatively short time.

Diseases

Seed sources. Wheat seed produced in Prince Edward Island is heavily contaminated with pathogenic organisms, particularly *Fusarium* sp. Studies showed that local seed yielded less than seed from Alberta and that it yielded as well as the seed from Alberta when it was seeded at a 60% higher seeding rate and treated with the fungicide Vitaflo 280.

Fusarium head blight and mycotoxin production. Wheat seed was found to be contaminated by high levels of *Fusarium* and by the mycotoxin deoxyniralenol (vomitoxin). In fungicide evaluation tests, CGA64250 (Ciba-Geigy) at an application rate with active ingredient (a.i.) at 125 g/ha at the heading stage, demonstrated the best control (53.8%) of *Fusarium* head blight of wheat. In 1980 spray evaluations, CGA64250 reduced vomitoxin levels in barley from 9.17 to 5.54 mg/kg and in wheat from 4.18 to 3.09 mg/kg.

Intensive cereal production

Management studies. Evaluation of intensity of management on eight lodging-resistant varieties of spring wheat indicated that although higher yields were obtained by using fungicides and increasing N application, the ranking of varieties was similar under different management levels.

Lodging control studies. Lodging and stem breakage are yield- and quality-limiting factors in barley and oat production in the Maritime Provinces. Studies indicate that stem breakage may be reduced in severity by variety selection and by the use of correctly timed applications of such fungicides as CGA64250. Crop lodging was prevented with the use of growth regulators, but yield benefits were not evident except for Sentinel oats. Field trials conducted in 1981 illustrated greater success in keeping cereals standing with the use of fungicides rather than growth regulators.

FORAGE CROPS

Evaluation of varieties and species

Pasture evaluation of ryegrass. Seven ryegrass varieties, including Italian and Westerwolds types, were seeded and grazed by sheep at two grazing frequencies. Lemtal ryegrass equaled Merwester but exceeded the other five varieties in dry-matter (DM) yield, and it also had the highest percentage of ground cover. Increased grazing frequency reduced the yield and persistence of some varieties.

Timothy and annual ryegrass silages. Timothy (Climax), Italian ryegrasses (Lemtal and Barmultra), and Westerwolds ryegrasses (Promenada, Barspectra, and Merwester) were cut twice, field-wilted to about 30% DM content, and made into silages. Sheep trials showed better consumption and digestibility for first-cut ryegrass silages compared with first-cut timothy silage; however, these two species were equal as second-cut silages. Timothy produced 4.4 t/ha of digestible dry matter in two cuttings. Italian ryegrasses yielded 10% less and Westerwolds ryegrasses 10–30% more than timothy.

Management and nutrition

Winter survival. A midwinter thaw occurred in early February, 1981, resulting in flooding of many fields in the Maritime Provinces and adversely affecting winter survival of perennial crops and winter cereals. Waterlogging followed by freezing caused injury to alfalfa, red clover, and winter wheat in large areas of western Prince Edward Island, some areas of New Brunswick, and limited areas in Nova Scotia.

Analysis of overwintering alfalfa plants in Prince Edward Island during and after the winter flooding showed a decrease in carbohydrate reserves, a decomposition of proteins in the roots, an accumulation of ethanol, methanol, acetic acid, and *n*-butyric acid, and a trace amount of lactic acid, indicating that fermentation had occurred in the roots under anaerobic soil environments. The concentration of fermentation products remained high for several weeks after the winter flooding, suggesting a much slower exclusion of abnormal metabolites under low-temperature conditions in winter compared with summer conditions. The concentration and kinds of fermentation products varied not only with time after flooding, but also among locations, depending upon the oxygen content of soil and field drainage. These observations suggest that field-drainage conditions during winter are extremely important for successful winter survival of alfalfa, and that winter drainage, which is difficult to determine by conventional methods, can be assessed indirectly by analyzing fermentation products of test plants growing in the field.

Evaluation of winterhardiness of 3-yr-old alfalfa plants at Charlottetown showed that Mn-Syn-2, SQ-Syn-2, and Algonquin alfalfas were more resistant to midwinter thaws and winter flooding, thus surviving better than Saranac, Iroquois, Anik, and other varieties examined. Resistance to midwinter thaw appears to be an essential component of winterhardiness of plants in the Maritime Provinces.

Freezing resistance of 3-mo-old red clover plants was determined in a coldroom. Single-cut varieties (Norlac and Altaswede) were more resistant than double-cut varieties (Florex, Ottawa, Hungaropoli, and Bytown). Mean 50% lethal temperatures for the single-cut and the double-cut types were −11 and −9°C, respectively. Among the double-cut types, Florex was most resistant. This freezing test method appears useful for selection of hardy red clovers.

Pasture renovation with reduced tillage techniques. Alfalfa and bird's-foot trefoil were sod seeded at locations previously cut for conserved feed or used for pasture. Drilling was done with a John Deer PowrTill 1500 renovator and an Øyjord plot drill equipped with shoe openers. Existing vegetation was sprayed with paraquat or glyphosate at the time of drilling. Sod-seeded alfalfa resulted in greater DM yields than bird's-foot trefoil. Alfalfa and bird's-foot trefoil constituted 27 and 17% of the total yield in the year after sod seeding and 17 and 4% in the 2nd yr after drilling, respectively. Alfalfa performed better in a sward previously cut for conserved feed, whereas bird's-foot trefoil performed better in a field previously used for pasture. Both the PowrTill and plot drill resulted in satisfactory seedling establishment, although the yields of sod-seeded legumes were greater with the pilot drill than with the PowrTill in the year after drilling. Vegetation suppression with paraquat and glyphosate did not improve the growth of sod-seeded alfalfa or bird's-foot trefoil over the unsprayed control. In a heavy

sward consisting mainly of Kentucky bluegrass, sod seeding resulted in a failure of stand establishment.

Rapid field-drying of red clover with K solution. Dollard red clover was cut at the 10% bloom stage and sprayed with a 1.6% (wt/vol) aqueous solution of potassium carbonate at the rate of 200 L/ha. During a 9-h field-drying period following cutting on a clear day, the moisture concentration per unit of DM decreased 45% faster in sprayed herbage than in the control.

Corn silage production and quality. Delaying harvest beyond 1 October decreased yield slightly over 3 yr, but reduced whole plant in vitro digestibility significantly, thus reducing the digestible DM yields. Declining digestibility resulting from delaying corn harvest was demonstrated also in a sheep-feeding trial.

Control fertility studies. Applications of zinc in the fertilizer band or sprayed on the leaves failed to improve forage corn yields at two low-zinc test locations, in spite of increasing zinc levels in the leaves from below 14 mg/kg to well above 20 mg/kg.

Nutrient status of cereals and forage legumes. Phosphorus (P) and potassium (K) were deficient in several alfalfa and red clover crops sampled in Prince Edward Island. Cereal crops were adequate in K but a few were deficient in P. A number of forage legume and cereal crops were borderline in sulfur, molybdenum, zinc, and manganese. Depending upon the soil test, a number of forage legume crops could benefit from additional P application and some cereal crops from additional nitrogen (N) and P application.

Residual effect of soil-applied selenium on crop uptake. When selenium (Se) was applied to the soil at rates of 1 and 2 kg/ha, Se levels above 0.1 mg/kg were maintained in barley kernels for 2 yr and in timothy plant tissue for 3–5 yr. Crop tissue levels above 0.1 mg/kg Se were maintained in alfalfa and red clover for 2 yr with an Se application rate of 0.5 kg/ha. Liming the soils to greater than pH 6 was found to be beneficial in increasing the crop tissue Se levels.

Insects and diseases

Alfalfa blotch leafminer parasites. Six parasites have been reared from larvae of the alfalfa blotch leafminer. *Diglyphus intermedius* (Girault) was reared from specimens taken from Nova Scotia and Prince Edward Island, whereas *D. begini* (Ashmead), *Pnigalio* sp. (new), *Pnigalio maculipes* (Ashmead), *Notanisomorpha* sp., and *Dacnusa dryas* (Nixon) were reared from Prince Edward Island specimens only. The importance of some of these species in suppressing leafminer populations in the Maritime Provinces is not known. *D. dryas*, an imported solitary endoparasite, attacks the leafminer at the larval stage, and the parasitoid completes its development during the pupal stage. This species has been shown to be of considerable benefit in suppressing leafminer populations in the United States. It is now well established in Prince Edward Island and was released in Nova Scotia during 1981.

European corn borer causes losses in grain corn. A single application of granular cypermethrin (a.i. at 0.1 kg/ha) applied over the whorls of Pioneer 3955 grain corn gave almost 100% control of European corn borer. Insect control reduced stalk damage and increased grain yield by 12%. Other granular treatments (permethrin and quinalphos) or sprays (FCR-1272 (Chemagro Ltd.), cypermethrin, decamethrin, and quinalphos) reduced corn borer damage but did not increase yields. A 3-yr study indicated that the corn borer reduced grain yield, but earlier studies showed that this pest did not cause significant losses in silage corn yields.

Factors affecting Fusarium infections of forage legume roots. In a study on the *Fusarium* species associated with root rot of forage legumes, *F. oxysporum* Schlecht. generally occurred most frequently, followed by *F. roseum* (Lk.) emend. Snyder & Hansen and *F. solani* (Mart.) App. & Wr. The incidence of *Fusarium* was usually more variable in rootlets than in taproots. There was no consistent effect on the incidence of *Fusarium* infection among five locations studied in Prince Edward Island. When alfalfa was preceded in the crop rotation by winter wheat, spring wheat, timothy–bird's-foot trefoil mixture, or alfalfa–red clover–timothy mixture there was no consistent effect on the incidence of *Fusarium* infection. The incidence of *Fusarium* infection was similar

in alfalfa and bird's-foot trefoil. Except in rootlets, the incidence of *Fusarium* infection increased with increasing age of plants. The incidence of *Fusarium* in forage legume roots was reduced when *Fusarium* inoculum in the soil was reduced by methyl bromide fumigation and when root-invading nematodes (*Pratylenchus penetrans* (Cobb) Filipjev & Shuur.-Stekh.) were reduced by a preplant fenamiphos treatment.

CATTLE

Selenium status of dairy herds

A study of the serum Se values of 48 Prince Edward Island dairy herds showed that 16 out of the 36 herds that were being fed home-grown grain rations were Se deficient. None of the 12 herds that were being fed commercial rations, based on imported western grains, were Se deficient. The need for Se supplementation of home-grown feeds in this province was demonstrated.

HORTICULTURAL CROPS AND TOBACCO

Potato management and pest control

Small whole-seed production. Bintje has good potential for small whole-seed production. When the seeds were planted close together (10 cm) and the plants were top killed on 4 August, the yield was 27 t/ha, and 96% of the tubers were less than 60 mm; when the plants were top killed on 17 August, the yield was 34 t/ha, and 93% of the tubers were less than 60 mm in diameter.

By planting at 10–16 cm and top killing in late August, two cooperating potato producers obtained yields of 25 and 35 t/ha of Kennebec and 17 and 22 t/ha of Sebagoes, with 80–95% of the tubers less than 70 mm in size.

Fertility. No significant differences in a field trial were observed in either yield or size distribution of Russet Burbank potatoes because of the application of either a microbial soil inoculant, Symbex (Agro-K Corp.), or Symbex and a supplemental fertilizer, Symbooster Plus (Agro-K Corp.). Significant yield increases did occur, however, with the application of increasing rates of an N–P–K fertilizer irrespective of the presence or absense of either Symbex or Symbex and Symbooster Plus. In a complementary greenhouse experiment, ryegrass yields also responded to fertilizer treatments, but did not respond to the application of either Symbex or Symbex and Symbooster Plus.

Control of late blight. Use of the systemic fungicide Ridomil (Ciba-Geigy) following a protectant program was found to provide reasonabl ontrol of late blight (caused by *Phytophthora infestans* (Mont.) de Bary) early in the growing season. However, later in the season when late blight reached epidemic levels, the chemical did not provide adequate disease control.

Seed-piece treatment. Easout (Ciba-Geigy) provided adequate control of seed-piece decay caused by *Fusarium sambucinum* Fckl. f. sp. Wr. 6 and *F. solani* var. *coeruleum* (Sacc.) Booth and reduced the incidence of wilt caused by *Verticillium albo-atrum* Reinke & Berth. Mertect (Merck, Sharpe & Dohme), a fungicide for postharvest storage rot control, also provided some control of these diseases, although high rates were slightly phytotoxic to cut seed.

Postharvest ELISA testing. Performance of the Gugerli test borer (Pollähne) was evaluated for preparing extracts of dormant tubers for postharvest ELISA testing. By pooling a minimum of five borings per tuber the procedure showed excellent potential for the reliable detection of potato viruses X (PVX), S (PVS), and leafroll (PLRV) in both primary- and secondary-infected tubers.

Control of nematodes. Aldicarb, applied as 10 or 15% granular, with a.i. at 1.68, 2.24, or 3.36 kg/ha, in the row at planting, reduced populations of *Pratylenchus penetrans* in 24 commercial potato fields. A comparison was made also between plots treated with aldicarb 10% granular, with a.i. at 2.24 kg/ha and those treated with disulfoton 15% granular, with a.i. at 3.36 kg/ha. Average yields from the combined results of Kennebec, Superior, Sebago, and Russet Burbank varieties were about 13% higher in the aldicarb treatments. Yields in six fields where aldicarb was applied at an a.i. rate of 3.36 kg/ha were not different from those in adjacent fields treated with lower rates of aldicarb.

Quack grass control. Glyphosate at 1.12 kg/ha gave good control of quack grass in grain stubble at Charlottetown. Control was greater when application was made in late

October (82%), when quack grass had more leaf area, than in late September (62%). A pretreatment of the quack grass with N as NH_4NO_3 at 35 kg/ha 30 days before glyphosate application did not improve level of control. Comparison of glyphosate at 0.56, 1.12, and 2.24 kg/ha in the fall and spring showed that glyphosate gave better control, 1 yr after initial treatment, when applied in the fall (56 and 84%) than when applied in the spring (0 and 27%) at the two lower rates of application. At the 2.24 kg/ha rate of glyphosate, no differences were noted between seasons of application.

Vegetables and tobacco

Effects of seed spacing and fertilizer on pea yields. Field experiments conducted at nine locations over a 3-yr period in Prince Edward Island showed that yields of Dark Skin Perfection and Medalist peas were not affected by seeding in rows spaced 9, 13.5, and 18 cm apart with various in-row spacings of 4–10 cm. Also, a preplant broadcast application of 15-15-15 commercial fertilizer at 392 kg/ha failed to increase yields.

Pesticides. In recent years, insects such as the cabbage maggot have shown a three- to fourfold increase in tolerance to insecticides such as carbofuran and fensulfothion. Also, fensulfothion has failed to control root maggot infestations in rutabagas during abnormally wet growing seasons. Nevertheless, these compounds continue to give effective control in most areas of Atlantic Canada. An exception to the above situation is that for the past 2 or 3 yr carbofuran has failed to give any protection to root crops in specific areas that have had an extensive history of pesticide use. Soil samples from these areas were found to contain microorganisms that degraded carbofuran more than 5000 times faster than in sterilized soils or in soils from areas where carbofuran gave good root maggot control in 1981.

Tobacco varieties. Islangold and Windel were licensed in 1981 after a 3-yr evaluation in Prince Edward Island Both varieties have superior yields to previously recommended varieties. In addition, Islangold tobacco has good physical characteristics and Windel shows some resistance to wind damage.

Nematodes in tobacco. A 3-yr survey in tobacco fields in Prince Edward Island indicated that populations of root-lesion nematodes (*Pratylenchus* sp.) were small. No other plant-parasitic nematodes were recovered in sufficient quantity to warrant concern.

PUBLICATIONS

Research

Choo, T. M. 1981. Doubled haploids for estimating mean and variance of recombination values. Genetics 97:165-172.

Choo, T. M.; Kannenberg, L. W. 1981. Comparison of predicted and simulated responses to mass selection in a diploid, cross-fertilized species. Can. J. Plant Sci. 61:1-8.

Choo, T. M.; Kannenberg, L. W. 1981. Comparison of predicted and simulated responses to S_1 selection in a diploid, cross-fertilized species. Can. J. Plant Sci. 61:9-15.

Greenhalgh, R.; Read, D. C. 1981. Persistence of fensulfothion in a sandy-loam soil and uptake by rutabagas, carrots, and radishes using microplots. J. Environ. Sci. Health B 16:363-379.

Gupta, U. C. 1980. Analytical methods for determining micronutrients in plants and soils. Pages 116-133 *in* S. K. De, ed. Soil Sci. Agric. Chem. Part I. Indian Soc., Agric. Chemists Publ. Indian Soc. Agric. Chem., Allahabad, U.P.

Gupta, U. C.; Lipsett, J. 1981. Molybdenum in soils, plants and animals. Pages 73-113 *in* N. C. Brady, ed. Advances in agronomy, Vol. 34. Academic Press, New York, N.Y.

Gupta, U. C.; MacLeod, J. A. 1981. Plant and soil boron as influenced by soil pH and calcium sources on podzol soils. Soil Sci. 131:20-25.

Gupta, U. C.; Willis, C. B. 1982. Effects of soil fumigation and liming on yield and nutrient concentration of alfalfa and timothy. Can. J. Plant Sci. 62:125-130.

Gupta, U. C.; Winter, K. A. 1981. Long term residual effects of applied selenium on the selenium uptake by plants. J. Plant Nutr. 3:493-502.

Ivany, J. A. 1981. Quackgrass (*Agropyron repens* L. Beauv.) control with fall-applied glyphosate and other herbicides. Weed Sci. 29:382-386.

Kimpinski, J.; Willis, C. B. 1981. Influence of soil temperature and pH on *Pratylenchus penetrans* and *P. crenatus* in alfalfa and timothy. J. Nematol. 13:333-338.

Langille, J. E.; MacLeod, J. A.; Smeltzer, G. G.; Bubar, J. S. 1981. Finale Peas. Can. J. Plant Sci. 61:1001-1002.

Martin, R. A.; Edgington, L. V. 1980. Effect of temperature on efficacy of triadimenol and fenapanil to control loose smut of barley. Can. J. Plant Pathol. 2:201-204.

Martin, R. A.; Edgington, L. V. 1981. Comparative systemic translocation of several xenobiotics and sucrose. Pestic. Biochem. Physiol. 16:87-96.

Narasimhalu, P. R.; Belz .e, R. J.; Brisson, G. J.; Holtmann, W. B. 1980. Phase feeding of urea after feeding soybean meal to dairy cows. J. Dairy Sci. 63:2044-2050.

Narasimhalu, P. R.; Black, W. N.; McRae, K. B.; Winter, K. A. 1981. Effects of annual raté and timing of N fertilization on production of timothy, bromegrass, and reed canarygrass. Can. J. Plant Sci. 61:619-623.

Narasimhalu, P. R.; Kunelius, H. T.; Winter, K. A. 1982. Rapid determination of dry mattar in grass silage of *Lolium* sp. using a microwave oven. Can. J. Plant Sci. 62:233-235.

Nass, H. G.; Sterling, J. D. E. 1981. Comparison of tests characterizing varieties of barley and wheat for moisture stress resistance. Can. J. Plant Sci. 61:283-292.

Read, D. C. 1981. Adulticidal and larvicidal toxicity of aldicarb when applied as a soil insecticide. J. Econ. Entomol. 74:40-44.

Read, D. C. 1981. Toxicity of propoxur in wet and dry mineral soil to adults and larvae of the cabbage maggot, *Hylemya brassicae* Weidemann (Diptera: Anthomyiidae). Can. Entomol. 113:1093-1100.

Read, D. C.; Greenhalgh, R. 1981. Residual toxicity of fensulfothion in soil and uptake of toxic residues by rutabagas and carrots during wet and dry growing seasons. J. Econ. Entomol. 74:319-322.

Sanderson, J. B.; Daynard, T. B.; Tollenaar, M. 1981. A mathematical model of the shape of corn leaves. Can. J. Plant Sci. 61:1009-1011.

Singh, R. P.; McDonald, J. G. 1981. Purification of potato virus A and its detection in potato by enzyme-linked immunosorbent assay (ELISA). Am. Pot. J. 68:181-189.

Suzuki, M.; Cutcliffe, J. A. 1981. Sugars and eating quality of rutabagas. Can. J. Plant Sci. 61:167-169.

Suzuki, M.; Thompson, L. S. 1981. Effects of alfalfa blotch leafminer on chemical components of alfalfa. Can. J. Plant Sci. 61:595-600.

Thompson, L. S. 1981. Field evaluation of insecticides for the control of the alfalfa blotch leafminer and its effect on alfalfa yields in Prince Edward Island. J. Econ. Entomol. 75:363-365.

White, R. P.; Gupta, U. C. 1982. Macro- and micronutrient status of corn grown in Prince Edward Island. Can. J. Plant Sci. 62:215-218.

White, R. P.; Munro, D. C. 1981. Magnesium availability and plant uptake from different magnesium sources in a greenhouse experiment. Can. J. Plant Sci. 61:397-400.

Willis, C. B. 1981. Reaction of five forage legumes to *Meloidogyne hapla*. Plant Dis. 64:149-150.

Miscellaneous

Cutcliffe, J. A. 1981. Effect of time of terminal bud removal on single-harvest yields of "Jade Cross" Brussels sprouts. Canadex 252.24.

Cutcliffe, J. A. 1981. Effects of N, P, and K on yields of broccoli. Canadex 532.

Gupta, U. C.; MacLeod, J. A. 1981. Effect of liming on boron concentration of crop tissues. Canadex 530.

Gupta, U. C.; Willis, C. B. 1981. Concentrations of macro and micronutrients in forage crops after soil fumigation. Canadex 531.

Ivany, J. A. 1980. Early weed competition reduces rutabaga yield. Canadex 163.641.

MacLeod, J. A.; Johnston, H. W.; Sanderson, J. B.; Nass, H. G. 1981. Intensive management of winter wheat. Canadex 112.21.

Read, D. C. 1981. Controlling soil insect pests of row crops. Can. Agric. 26(2):27-29.

Sanderson, K. R.; Cutcliffe, J. A. 1980. Thirty-one years of strawberry cultivar evaluation trials. Agric. Can. Tech. Bull. Supply and Services Can. Cat. No. A22-98/1980E. 7 pp.

Thompson, L. S. 1981. A nuclear polyedrosis virus for control of European skipper in P.E.I. Canadex 630.

White, R. P.; Platt, H. W.; Collins, W. B. 1980. Growing Netted Gems for processing. Canadex 258.21.

Willis, C. B. 1981. Forage species differ as hosts for two species of root lesion nematodes. Forage Notes 25:33-37.

Winter, K. A. 1981. Weaning dairy calves at 3 weeks and feeding fermented colostrum. Agric. Can. Publ. 1721. 9 pp.

Winter, K. A.; Gupta, U. C. 1981. Increasing the selenium content of feedstuffs. Can. Agric. 26(3):22.

Research Station
Kentville, Nova Scotia

PROFESSIONAL STAFF

Administration

G. M. Weaver, B.Sc., Ph.D.	Director
D. L. Craig, B.Sc. (Agr.), M.S., Ph.D.	Assistant Director, Operations
R. G. Ross, D.F.C., B.Sc. (Agr.), M.Sc., Ph.D.	Assistant Director, Program
G. P. Shortt	Administrative Officer

Scientific Support

K. B. McRae, B.Ed., M.S., Ph.D.	Statistician
J. R. Miner,[1] B.A., M.L.S.	Librarian
D. C. Ottoson,[2] B.A.	Programmer

Crops

D. L. Craig, B.Sc. (Agr.), M.S., Ph.D.	Head of Section; Plant breeding
L. E. Aalders, B.Sc., M.Sc., Ph.D.	Genetics and plant breeding
C. R. Blatt, B.Sc., M.S., Ph.D.	Physiology and nutrition
I. V. Hall, B.Sc., M.Sc., Ph.D.	Ecology and physiology
P. R. Hicklenton, B.Sc., M.Sc., Ph.D.	Ornamental physiology
R. W. Jones, B.Sc., M.Sc., Ph.D.	Cereal crops physiology
N. L. Nickerson, B.Sc., M.Sc.	Tissue culture
C. L. Ricketson, B.Sc. (Agr.), M.S., Ph.D.	Vegetable physiology

Entomology

A. W. MacPhee, B.Sc. (Agr.), M.Sc., Ph.D.	Head of Section; Insect ecology
H. J. Herbert, B.Sc. (Agr.)	Pheromones and mites
W. T. A. Neilson, B.Sc., M.Sc.	Fruit maggots
K. H. Sanford, B.Sc. (Agr.), M.Sc.	Integrated control programs
H. B. Specht, B.Sc. (Agr.), M.S., Ph.D.	Vegetable and field crop insects

Plant Pathology and Pesticide Residues

R. G. Ross, D.F.C., B.Sc. (Agr.), M.Sc., Ph.D.	Head of Section; Tree fruit diseases
M. G. Anderson, B.Sc., Ph.D.	Vegetable storage diseases
S. O. Gaul, B.Sc., M.Sc.	Residue chemistry
C. O. Gourley, C.D., B.Sc. (Agr.)	Berry crop diseases
K. I. N. Jensen, B.S., M.Sc., Ph.D.	Herbicide physiology
E. R. Kimball, B.Sc.	Residue chemistry
C. L. Lockhart, B.Sc. (Agr.), M.Sc.	Horticultural pathology
M. T. H. Ragab, B.Sc., M.Sc., Ph.D.	Residue chemistry

Poultry

F. G. Proudfoot, B.Sc. (Agr.), M.S.	Head of Section; Physiology and genetics
H. W. Hulan, B.Sc. (Agr.), M.Sc., Ph.D.	Nutrition and physiology

Processing, Distribution, and Retailing

R. Stark, B.Sc., Ph.D.	Head of Section; Food technology
P. D. Lidster, B.Sc., M.S., Ph.D.	Storage physiology
P. A. Poapst, B.Sc. (Agr.)	Storage physiology
W. G. Simpson, B.S.A., M.S.	Technological services

Tree Fruits

A. D. Crowe, B.Sc. (Agr.), M.Sc., Ph.D.	Head of Section; Plant breeding and physiology
D. H. Webster, B.Sc., M.Sc., Ph.D.	Soils and nutrition

Departures

K. M. CARTER, B.Comm.	Administrative Officer
M. L. C. PEVERIL, B.Sc.	Programmer
Resigned July 1981	

Experimental Farm, Nappan, N.S.

F. W. CALDER, B.Sc. (Agr.), M.S.	Officer in Charge; Forage crops agronomy
J. E. LANGILLE, B.Sc. (Agr.)	Agronomy, cereal and forage crops
T. A. VAN LUNEN, B.S.A.	Swine management and nutrition

[1]Seconded from Libraries Division, Finance and Administration Branch.
[2]Seconded from Systems and Consulting Division, Finance and Administration Branch.

INTRODUCTION

This report highlights the principal research results from the Kentville Research Station and the Experimental Farm at Nappan for 1981. Kentville is the center for research in horticulture, poultry, food technology, and pesticide residues in the Atlantic Provinces. The Experimental Farm at Nappan, 80 km north of Kentville, serves as an associate establishment doing applied and developmental research on the production of cereals, forages, and lowbush blueberries, and on the management of livestock. The Atlantic region is characterized by a cool, humid climate and by Podzol soils, which sustain a diverse agriculture.

The Kentville Agricultural Centre was officially opened on 15 June 1981 by the Honorable Eugene F. Whelan, Minister of Agriculture for Canada, and the Honorable Roger S. Bacon, Minister of Agriculture and Marketing for Nova Scotia. This event was well-publicized throughout the region and provided an opportunity for many thousands of industry and community people to view the new facilities and to see aspects of current research under conduct at the Centre.

Requests for further information or reprints of publications should be addressed to the Research Station, Research Branch, Agriculture Canada, Kentville, N.S. B4N 1J5.

G. M. Weaver
Director

BREEDING, NUTRITION, AND CULTURE OF CROPS

Grapes

Cultivar testing. The cultivars Castel 19637, DeChaunac, Dalniewostoznyd Ramming, Marechal Foch, Michurinetz, Precose de Colmar, and Severnyi, previously identified as having potential in this area for table wine production, had good fruit bud survival following a winter sufficiently severe to kill apple trees. Damage to the 54 cultivars on test varied from nil for Severnyi and Michurinetz to total vine death for Schuyler and Muller Thurgau. Fruit yield varied from 7 to 10 kg per vine. Juice-soluble solids and acid level were similar to those previously recorded. Cultivars such as Michurinetz and Severnyi were fully mature by 20 September.

Lowbush blueberries

Velvet-leaf blueberry. Vaccinium myrtilloides is a woodland species with acuminate bud scales and characteristic entire, pubescent leaves. It forms up to 90% of the stand of some commercial lowbush blueberry fields of New Brunswick and Maine, which have been derived from cut-over woodland. The flowers require cross-pollination by bees or andrenids for fruit production. In seedling development, the seed sends out a radicle after 20 ± 7 days, cotyledons emerge after 31 ± 8 days, and the first leaves unfold after 48 ± 6 days. The number of large, viable seeds per berry in the field is 16 ± 10; the weight is 26 ± 7 mg/100 seeds. *V. myrtilloides* is a diploid and is not compatible with *V. angustifolium*, a tetraploid with which it is often associated. The berries of the two species are gathered together at harvest and cannot be separated on taste, color, or flavor.

Blomidon lowbush blueberry. Blomidon, a vigorous and high-yielding lowbush blueberry cultivar with attractive fruit, is from the Kentville Research Station. It is the first named lowbush blueberry cultivar from controlled breeding.

Lowbush blueberry management and nitrogen fertilization. The lowbush blueberry clones Augusta, Chignecto, and 74-2 have been fruited for the last 4 yr in a field experiment that has been ongoing for 6 yr. In an attempt to maximize grower returns in the establishment years of a cultivated lowbush blueberry planting, successive cropping in the third and fourth seasons following planting appears to be an advantageous practice, when compared with the traditional crop–burn–crop system over the same season. Urea supplied at a N level of 56 kg/ha in the spring of each sprout year appears to increase marketable yield, compared with a control in both management systems.

Raspberries

Red raspberry breeding. Seven seedling selections outstanding for yield, fruit size, firmness, and winterhardiness were selected at Kentville from 1482 seedlings planted in 1979. These selections were derived from intercrossing superior cultivars and seedling selections from the Vancouver, Ottawa (now terminated), and Kentville red raspberry breeding programs. K74-1 (Avon × Matsqui) from the Kentville breeding program will be released for wider testing. Earliness, yield, light fruit color, and the ability to maintain quality under field conditions suggest a good potential for pick-your-own purposes.

Strawberries

Breeding. Regional cultivar trials conducted at the Agriculture Canada Research Stations located at Kentville, N.S., Charlottetown, P.E.I., and Fredericton, N.B., and the Senator Michaud Experimental Farm at Buchtouche, N.B., have identified the Kentville selection K74-12 (Micmac × Bounty) as a potential new cultivar for the region. After 3 yr of testing, K74-12's potential to produce very high yields of firm, large, quality fruit suitable for either fresh fruit or frozen sliced dessert was verified.

Two red stele (*Phytophthora fragariae*) tolerant selections, K78-4 (K74-5 × Earliglow) and K78-6 (Earliglow × Kent), from the Kentville breeding program have been multiplied by a commercial nursery, in order to increase the supply of plant material for nursery purposes and for the establishment, in 1982, of a large-scale fruiting test by a commercial grower.

Seedling inoculation with a strain complex of the red stele organism was again done at Kentville. The inoculation survivors (2308), which were planted in land infested with red stele, will be evaluated in 1982. Two selections were made in 1981 from the field testing of 1478 inoculated seedlings planted in infested soil in 1980. A total of 21 seedling selections from this phase of the Kentville breeding program are under test in Station field plots.

A management study with Bounty. Trickle irrigation, black plastic mulch, and a double-row alternate planting system were applied in all combinations to the Bounty strawberry. The first crop was harvested in 1981, and all fruit was mechanically graded into six grades, with fruit in grades 4–6 considered as marketable and fruit in grades 1–3 considered as suitable only for processing. As was expected, the double-row alternate planting system gave significant yield increases compared with the conventional single-row system. The use of black plastic significantly increased marketable yields in the second and fourth harvests, when the third, fourth, and fifth harvests were combined (late), and when all harvests were combined (total).

Tree fruits

Winter-hardy stocks for intensive apple production. Ottawa 3 is a new apple stock cultivar that shows promise. Trials located at Fredericton, N.B., and at Kentville, N.S., indicate that this stock causes the scion cultivar, for example McIntosh, to come into production with early yields of top-quality fruit. Ottawa 3 makes a better trunk structure than does Malling 26 and is more hardy than Malling 9.

Major emphasis in this work done by the Kentville Research Station is toward using Ottawa 3 as a stem piece rather than as a root. By using the dwarfing Ottawa 3 in proper combination with the excellent but more vigorous rootstock Beautiful Arcade, also developed at Kentville, growers can get just the size of tree they want without excessive pruning. Although the best combination of stem piece and rootstock for each scion cultivar (whether the scion cultivar be Crimson Gravenstein, McIntosh, Red Delicious, Spy, etc.) will take some years to work out, growers are now becoming enthusiastic about the possibility of having their favorite nursery produce apple trees tailor-made for intensive high-quality fruit production.

Cereals

Barley yields increased with the fungicide Bayleton. Atlanta barley seeded on 22 May and 3 June was sprayed with the fungicide Bayleton at the boot stage. Four random samples were taken from each of the two sprayed areas and four samples from each of the two check areas. A 21% increase in barley yield was found on the fungicide-treated, early seeded area. About 52% of the flag leaf on the check area was diseased, whereas only 6% of the flag leaf was diseased on the sprayed area. Where weight per 1000 kernels was measured, there was a 6% increase in weight of kernels on the area treated with

Bayleton over the unsprayed area. No significant difference in yield was found on the late-seeded Atlanta barley when sprayed with Bayleton, over the unsprayed area.

Dankowskie Srebrne fall rye. The cultivar Dankowskie Srebrne fall rye, developed in Poland, continues to perform well in regional fall rye trials in the Maritimes. The cultivar is high yielding and appears to be winter-hardy when grown under Maritime conditions. This cultivar has been recommended for licensing by the Atlantic Advisory Committee on Cereal and Protein Crops and the Canada Expert Committee on Cereal Crops.

Bird damage to small grains. In 1981, a cooperative study was carried out to examine bird damage to early seeded spring wheat at Nappan. This was part of a survey carried out on three areas of dikeland and three areas of upland seeded to grain in Cumberland County, N.S. Cages were used to determine grain loss, and observations on birds were made at 8:00 a.m. and 4:00 p.m. There was a 2.9% loss of grain at Nappan because of birds. There were 239 birds observed in the plots, and bobolinks were the most common bird species found on dikeland. This was true for both 1980 and 1981.

Response of winter wheat to N carrier and level in the field. Three cultivars, representing winter wheat adapted to Western Canada (Norstar), the Maritimes (Lennox), and continental Europe (Vuka), were spring-fertilized with nitrate, ammonium nitrate, ammonium sulfate, and urea at N levels of 70 and 140 kg/ha. Lennox was quick to respond and Norstar was slow, whereas Vuka's 2-wk unfertilized loss of fresh weight following the treatment date (14 April 1981) was turned around to a gain that increased with N level. Nitrate produced the most early growth on Lennox and Norstar and urea the least, a relationship that was reversed in Vuka. In Lennox, the advantage of nitrate was carried through to grain yield, with ears per square metre the main contributory yield component, whereas with Norstar urea had a slight yield advantage, expressed primarily through a lighter kernel weight. In Vuka, yield was not markedly differentiated among N carriers. Under Maritime conditions, therefore, there may be cultivar-specific N-carrier effects influencing spring vigor. These early effects may or may not, on their own, determine later yield parameters, again depending on the cultivar.

Vegetables

Comparison of two-row spacings for six bean cultivars. At a standard plant population of 301 500 plants per hectare, rows spaced 45.7 cm apart outyielded those spaced 91.4 cm apart by an average of 22%, for six cultivars of green and wax beans used for processing in Nova Scotia. All cultivars, Eagle, E. Gallatin, Stretch, Bonanza, Gold Rush, and Midas, responded similarly to narrowing of the rows. Spacing between rows did not influence pod size or the proportion of beans in size grades 3 and 4. No disease problems were encountered.

Plastic tunnels and mulches for slicing cucumber production. Clear polyethylene row tunnels with side ventilation slits increased early yields of the cultivar Marketmore 76 by 1690 dozen fruit per hectare, or 300%, over control plots. Black polyethylene soil mulch increased early yields by 600 dozen fruit per hectare, or 100%, over control plots. Tunnels and the black mulch also increased total yields over control plots by 2390 and 1650 dozen fruit per hectare, respectively, 40 and 28% increases. A woven black polypropylene soil mulch, Pro Pex, had no advantage over unmulched plots. Fruit size and appearance were not affected by the tunnels or mulches.

Row tunnels and soil mulches for tomatoes. Ripe fruit production of the cultivar Springset was hastened markedly by use of clear plastic row tunnels. Early yields to mid-August averaged 12 700 kg/ha for plants with tunnels versus 3100 kg/ha for plants without tunnels. Also, the total yield of ripe fruit was increased by tunnels, averaging 82 300 kg/ha for plants with tunnel plots versus 52 200 kg/ha for plants without tunnels, a 58% increase. The addition of clear or black polyethylene soil mulch either to plants with tunnels or those without tunnels did not affect early yields but did increase total yields by 20% for plants with tunnels (mulched plots yielded 87 000 kg/ha versus 73 000 kg/ha for unmulched) and 22% for plants without tunnels (mulched plots yielded 55 600 kg/ha versus 45 400 kg/ha for unmulched). Increased yields with tunnels are more than sufficient to pay for the materials and installation, but ventilation is a consideration; the tunnels required hand ventilating about seven times in this study. Increased yields can

justify the use of clear or black soil mulches, but black mulch is especially of interest because it also controls weeds.

Removal of terminal growth of young broccoli plants. Plants of broccoli cultivar Premium Crop, which had their growing tips pinched off at the time of transplanting to the field (plants 4 wk old), produced an average of 1.6 branches, with fairly large terminal heads per plant; terminal yield was 15 000 kg/ha versus 11 750 kg/ha for unpinched plants, a 28% increase. Pinching at later stages of growth (1, 2, 3, or 4 wk after transplanting) did not result in yield increases over unpinched plants. Pinching of the cultivar Gem at any of the stages of growth studied did not give yield increases over unpinched plants; therefore cultivars apparently respond differently to pinching.

Tomatoes—fertilizer rate and placement. Transplants of the Cabot tomato were set in a Berwick sandy loam and received several rates of N-P-K fertilizer, applied as follows: entire treatment banded at transplanting time, P banded at transplanting, and N-K broadcast preplant or entire treatment broadcast preplant. Plants receiving the 1-2-1 ratio produced marketable yields that were equal over all three application systems for all harvests prior to frost. Marketable yields for these harvests were equal from all plants receiving 1 or 2 units of P banded at transplanting. The ratio 1-1-1 with P banded and N-K broadcast gave marketable yields, before frost, equal to yields obtained with higher rates of application; however, yields after frost were significantly less than those obtained at higher rates. Thus, this ratio (1-1-1), rate (1 unit = 80 kg/ha N, P_2O_5, K_2O), and method of application (P banded, N-K broadcast) appear to be the most economical at present.

Ornamentals

Ornamental cultivar evaluations. A further 22 taxa of ornamental trees and shrubs were added to the test plots at Kentville during 1981, bringing the total number of taxa on trial at this Station to 50. First-year evaluations were conducted on 1980 plantings at L'Assomption Experimental Farm, Que., and at Kentville. These preliminary data indicated that recent introductions by Morden Research Station (*Ulmus japonica* 'Jacan' and *Populus* × *canescens* 'Tower') were both hardy and suitable for these two eastern locations. Other plants that performed well at both sites included the Blue Hollies (*Ilex* × *meserveae* 'Blue Princess', 'Blue Prince', and 'Blue Angel'), 'Northern Gold' *Forsythia* (a recent introduction by Ottawa Research Station), and 'Patmore' green ash. Growth and survival of six *Buxus* cultivars were inconsistent. Full evaluation results to date are available on request.

Overwinter storage of containerized ornamentals under white copolymer—characteristics of the thermal environment. Positioning of containerized evergreens in white copolymer storage houses has often been considered important in determining plant survival. More tender material is generally grouped in the center of the house, with the hardier species around the walls. Temperature monitoring at various locations within a white copolymer storage house throughout winter 1980–1981 indicated that container soil temperatures (8-cm depth) differed by no more than 1°C between the walls of the house and the center, during periods of extremely cold exterior air temperatures. Differences were apparently independent of wall orientation. Temperatures at various depths within the container (2 cm, 8 cm, and 15 cm in an 8 L container filled with 2:1 peat-to-soil mix) did not differ significantly.

Chrysanthemum growth in wood-waste based media. Pot chrysanthemums (cultivars Mountain Peak, Goldstar, and Cir Bronze) were successfully grown to maturity in a medium containing 1 part sawdust to 1 part peat moss (v/v) when fertilized with nutrient solution containing N at 150 or 200 mg/kg and K at 200 mg/kg. Days to flower, stem length, and total plant dry weight at harvest were similar in plants grown in sawdust–peat and peat–vermiculite–sand media. Levels of N, K, Mg, and Ca in leaf tissue at harvest did not differ significantly between media. Thus, for pot chrysanthemums, sawdust may be useful as an addition or substitute for peat moss, which continues to escalate in price.

Slow-release fertilizers, fungicide, and media effects on rooting of azaleas and rhododendrons. Osmocote 14-14-14 at a rate of 11 g/L medium in either sand or 1 part peat to 1 part sand (v/v) has proven detrimental to rooting in azalea and rhododendron cuttings. This finding is in contrast to the highly beneficial effects of Osmocote and other slow-release fertilizers, which have been

described for certain evergreens and deciduous species with needlelike leaves. Neither medium nor weekly soil drench applications of captan had any consistent effect on rooting in either azaleas or rhododendrons.

PROTECTION OF CROPS AGAINST PESTS

Plant pathology

Control of twig and blossom blight of lowbush blueberry with fungicides. Foliar sprays of Funginex at high and low rates and two applications of Funginex followed by two applications of Ferbam or Easout gave significant control of twig and blossom blight. Funginex at the low rate followed by Ferbam was effective and the most economic treatment for twig and blossom blight control.

Control of white mold on snap beans with fungicides. Any one of three foliar spray treatments—Benlate 50 WP at 5% bloom, Benlate 50 WP in a split application at 5% bloom and 1 wk later, or BCI 100 F 50 WP—gave significant control of white mold (caused by *Sclerotinia sclerotiorum* (Lib.) de Bary).

Control of red stele. A schedule of soil drenches of the systemic fungicide metalaxyl for the control of red stele disease of strawberry showed that a drench in the spring of the fruiting year, in addition to three fall drenches, increased mean yields by 19%.

Effect of timing and number of sprays of benomyl, fenarimol, and other fungicides on ascospore production in Venturia inaequalis (Cke.) Wint. Five to seven sprays of benomyl with active ingredient (a.i.) at 250 g/1000 L water applied to foliage infected by apple scab (caused by *Venturia inaequalis* (Cke.) Wint.) at 15-day intervals from 17 June to 24 September were required to suppress ascospore production in overwintered leaves. In a test where different numbers of sprays were applied from 18 July to 18 September, two to five sprays of benomyl with a.i. at 500 g/1000 L, three to five sprays of fenarimol with a.i. at 80 g/1000 L, or a mixture of benomyl and fenarimol each at half these rates suppressed ascospore production. Two sprays of fenarimol with a.i. at 80 g/1000 L and two to five sprays of fenarimol with a.i. at 40 g/1000 L did not give complete suppression. In a regular spray program for the control of apple scab, biloxazol with a.i. at 125 to 375 g/1000 L suppressed ascospore production.

Resistance of Botrytis cinerea to benomyl. Sixty-three percent of the isolates of the strawberry gray mold fruit rot fungus, *Botrytis cinerea*, from commercial plantings were resistant to benomyl fungicide.

Soil fumigation for apple replant. In an orchard with a severe apple replant problem, tree planting sites were fumigated either with chloropicrin at 336 L/ha or Vorlex at rates of 112–448 L/ha. In each of the first 4 yr of tree growth there was a significant response to all fumigation, but at 112 L/ha Vorlex may be at the lower limit of effectiveness.

Insect pests

Biology, life tables, and intrinsic rate of increase of the European red mite. Development of the European red mite, *Panonychus ulmi* (Koch), in Nova Scotia was studied at three constant temperatures to construct a life table and establish the intrinsic rate of development. The threshold temperature for development was 10.6°C. The duration from the beginning of the egg stage to adult for females was 31.2, 20.5, and 14.0 days, and for males 21.9, 19.6, and 12.8 days at 15, 18, and 21°C, respectively. The duration in degree-days above 10.6°C for females was 137.3, 151.7, and 145.2, and for males 128.0, 144.9, and 133.1 at the same three temperatures. The duration of the preoviposition period decreased, duration of the oviposition period remained constant, and the number of eggs laid increased with temperature. Life tables were constructed at 15, 18, and 21°C; the intrinsic rates of increase were 0.56, 0.092, and 0.134; net reproduction rates were 10.06, 13.50, and 17.37; and mean generation times were 41.4, 28.3, and 21.3 days, respectively.

Biology, life tables, and innate capacity for increase of the twospotted spider mite. The threshold temperature of development, life table, and innate capacity for increase of the twospotted spider mite, *Tetranychus urticae* Koch, were established from life-stage development studies at constant temperatures. The threshold for development was determined to be 10.0°C. The durations in degree-days above 10°C from the beginning of the egg stage to adult at 15, 18, and 21°C, respectively, were for females 141.3, 152.3, and 139.8; and for males 134.2, 144.7, and 135.2. Life tables were constructed, and innate

capacity for increase at 15, 18, and 21°C, respectively, was 0.069, 0.156, and 0.372; net reproduction rate 20.8, 38.4, and 58.1; and mean generation time 44.0, 23.4, and 10.9.

Apple orchard tests on the efficacy of the granulosis virus of the codling moth. The protection of apples against damage by the codling moth, *Laspeyresia pomonella* (Linnaeus), by applications of the granulosis virus of *L. pomonella* was assessed in apple orchard tests at four locations in Canada in 1974–1978. Sprays containing 3×10^9 to 4×10^{10} granules per litre, applied two or three times per generation of codling moth larvae, reduced injury to apples by 44–85% compared with reductions of 72–98% by applications of azinphos-methyl or phosmet. Applications of the virus did not reduce numbers of arthropods predaceous on pest insects and mites.

Evaluation of pesticides on tree fruits. Approximately 20 chemicals were evaluated against 20 pest and predator species in 1981. These included two growth regulators, several new pyrethroids, miticides, and insecticides. The annual application of pyrethroids for prebloom pest control proved not necessary. After the initial application, 1 or 2 yr without treatment is possible, thus allowing regulation of other pests and a lower insecticide load over several years. Tests have shown that controls applied in New Brunswick on egg-laying adults of the apple leaf curling midge, *Dasineura mali* (Kieffer), instead of on hatching eggs was more effective. Pyrethroids gave as good or better control than the previously recommended diazinon treatment.

Blueberry maggot control. Sprays or dusts for control of the blueberry maggot, *Rhagoletis mendax* Curran, are applied in July and are timed according to the ripening of the berries: the first application 10–20 July and a second, if needed, 7–10 days later. The need for control treatments is based upon the history of maggot (larvae) infestations in previous crop years and can result in the unnecessary use of insecticides, since the adults (the control target) may or may not be present because of natural control and management practices. The use of traps to monitor adult prevalence to determine the need for control treatments would be more appropriate, and recent tests have shown that this may be possible, because the adults were captured from early July to mid-August on Pherocon AM traps and 8.5-cm tartar dark red sticky spheres. However, the traps failed to detect the adults' presence in a few fields that were subsequently infested with maggot, and more information on adult distribution and trapping sites will be required before they can be recommended as a monitoring tool in our pest management program.

Pesticide residues

Efficacy of three dinitroaniline herbicides and their persistence in soils. The efficacy and relative persistence of dinitramine (N^4,N^4-diethyl-α,α,α-trifluoro-3,5-dinitrotoluene-2,4-diamine), ethalfluralin [*N*-ethyl-*N*-(2-methyl-2-propenyl)-2, 6-dinitro-4-(trifluoromethyl)-benzenamine], and trifluralin (α,α,α-trifluoro-2, 6-dinitro-*N*, *N*-dipropyl-*p*-toluidine) were studied in a series of field trials conducted on a Charlottetown fine silt loam and a Somerset sand. Phytotoxicity, as reflected by weed control and injury to the peas (*Pisum sativum* L.), was greater on the sandy soil, and herbicide rates recommended for the region may reduce yields on light soil types. The margin of crop tolerance was also reduced in 1 yr characterized by an extremely wet growing season. Under field conditions, there was little practical difference in weed control obtained with the three herbicides, but in greenhouse trials ethalfluralin gave superior control of a number of common annual grass weeds. Four commonly used pea cultivars did not exhibit differential tolerance to the three herbicides. The order of increasing field persistence was trifluralin > ethalfluralin > dinitramine. The herbicides were more persistent in the sandy soil than in the fine silt loam. Significant levels of the three herbicides were extracted from the upper 10.0 cm soil at harvest, 80 days after application.

Hexazinone—a selective herbicide for highbush blueberries. The herbicide hexazinone, (3-cyclohexyl-6-dimethyl-amino)-1-methyl-1, 3, 5-triazine-2, 4-(1*H*,3*H*)-dione, was selective in highbush blueberries when applied as a directed spray at rates that controlled a broad spectrum of perennial grass and broad-leaved weeds. Early spring applications to the soil before weed emergence gave significantly better weed control than fall treatments. Container-grown, 3-yr-old Berkeley and Bluecrop blueberries were injured by soil-applied hexazinone at levels of 1 and 2 kg/ha, respectively, which suggests differential tolerance among cultivars. Applications to foliage resulted in defoliation. In

field trials, however, injury was observed only at 4.0 kg/ha, but 2.0 kg/ha was sufficient for control of quack grass, goldenrod, hawkweed, sheep sorrel, and many other weeds.

Determination of glyphosate. A new method for the determination of glyphosate and its major metabolite in water was developed, using the molecular emission cavity analysis. Compounds were converted, in a fuel-rich nitrogen-cooled air-hydrogen flame, to HPO, which was measured at 526 nm. Ammoniacal ethylenediaminetetraacetic acid (EDTA) improved the recovery from hard water. The method is rapid and simple, and it does not require derivatization.

Dinoseb residues. Preemergence herbicide applications of dinoseb (Sinex PE) alone or in combination with the harvest potato vinekiller (Sinex General), and chlorbromuron in combination with Sinex General, were applied at various rates to Netted Gem potatoes. No dinosebs of chlorbromuron residues were found in the tubers at harvest as determined by electron-capture gas chromatography and thin-layer chromatography.

Permethrin for blueberry thrip control. Permethrin with a.i at 0.4 kg/ha controlled blueberry thrips, *Frankliniella vaccinii* Morgan. There was no plant damage and crop yield was notably increased. No permethrin residues were found in the berries, as determined by electron-capture gas chromatography and thin-layer chromatography.

PROCESSING, DISTRIBUTING, AND RETAILING

K-series blanching system. Contractual development of the K-series blanching system continued in 1981, with the third and final phase of the Co-Operative Project with Industry (COPI) development contract valued at $247 000. Although the K3 system, developed under the terms of this contract, represents a quantum jump in ease of operation and clean-up construction, it still retains the high efficiency ratings observed with previous test models. Over one million kilograms of product was run through the K3 blancher under test in the M. W. Graves Ltd. processing plant at Hillaton, N.S. Most of the raw material was difficult-to-blanch product such as cauliflower, broccoli, Brussels sprouts, and whole green beans. The blancher was run as a full-scale production unit on a continuous basis, with test periods of 1-h duration being conducted at frequent intervals.

The performance characteristics of the unit were excellent, with energy savings and effluent reduction benefits similar to those previously recorded in the K2M1 unit. This earlier model was awarded the prestigious 1981 Putman award as an outstanding development in food-processing equipment. A modified K3 heating section was tested as a tomato peeler in a California plant, with great success, indicating considerable potential for further development of the basic design principles.

Controlled-atmosphere (CA) storage of Brussels sprouts. CA studies performed on sprouts obtained from widespread North American sources and from local varietal trials indicated highly variable "keepability", which related to initial intrinsic quality factors and to cultivar. When stored at –0.25°C, the use of normal ratios of 3–8% CO_2 were satisfactory, whereas concentrations of 5% CO_2 when combined with subnormal O_2 (i.e. 2% ca.) risked internal browning or off-flavor or both. Storage was terminated at 189 days, or 2 mo beyond rated maximum storage. Excellent quality was obtained with Jack Cross E, Lunet, Citadel, and Lancelot cultivars. Further storage extension seems probable by using lower storage temperatures (–2°C ca.) and by identifying quality material.

Preharvest defoliation in rutabaga. Chemical defoliation in rutabaga is being scrutinized as a possible alternative to mechanical defoliation. Recently, it was found that inexpensive ammonium peroxydisulfate in 1–2% aqueous emulsion is an effective promoter of leaf drop when applied in the fall. Further, it was observed that the peroxide reduces the rate of root growth by more than 25% in normally rapid-growing crops. In earlier studies, ethephon at 5000–15 000 mg/kg was observed to be an effective but costly defoliant. Recent tests now show that the ethephon requirement can be reduced two to four times by formulating with ammonium peroxydisulfate. The meritorious aspects of size control and flexibility of harvest scheduling can be further developed by advancing spray dates into late summer, provided that regrowth, which develops with hot days, is controlled. This latter problem was effectively solved by formulating the peroxide with maleic hydrozide (MH-30) at 2500 mg/kg.

An inexpensive adaptable storage chamber suitable for experimental or home use. Simple and reliable methods for the construction and operation of small modified-atmosphere chambers were assessed. Simple disposable chambers may be constructed to any required dimension using 2.5 × 10.0 cm strapping as a frame to support an airtight skin (tar paper laminated on either side by aluminum foil, commonly used as a vapor barrier and insulant in building construction). The tar paper–aluminum foil laminate is adhered to the frame and sealed by veterinary vaseline. Oxygen control is provided for by opening and closing pinholes in the airtight skin, and carbon dioxide levels are maintained by adjustments of exchange surfaces to hydrated lime.

Physiological responses of McIntosh apples to modified-atmosphere storage. Exposure to 1.5% CO_2 + 1.0% O_2 (2.8°C) for 40 days or more suppressed the respiratory activity and softening of the fruit, as compared with similar fruit stored either in 5.0% CO_2 + 3.0% O_2 (2.8°C) or 0°C air storage. Fruit softening in 5.0% CO_2 + 3.0% O_2 was characterized by initial rapid texture loss, followed by more gradual texture decline. The fruit stored in 1.0% O_2 atmospheres, however, did not show the initial rapid softening, but the rate of texture loss was similar to that which occurred in 5.0% CO_2 + 3.0% O_2 after the rapid initial softening. This evidence suggests that several physiological mechanisms contribute to apple softening and that 1.0% O_2 atmospheres may selectively block that mechanism responsible for the rapid softening in conventional modified-atmosphere storage.

Potential for reduced energy input for modified-atmosphere storage of apples. Initial calculations indicated that energy savings of 7–15% were obtainable in three Canadian fruit-producing regions by raising storage temperature from 0°C to 5°C. The normal increased rate of fruit deterioration resulting from the elevated temperature may be overcome by reduction of the storage oxygen levels. The findings of 2 yr of testing indicate that oxygen/temperature combinations near 1.0% O_2/5°C may result in commercially acceptable McIntosh and Golden Delicious apples after 6–7 mo of storage.

ANIMAL SCIENCE

Hogs

Evaluation of sprouted grains as a feed source for swine. Producing a high-quality forage through the use of hydroponics, without interfering with confinement, was evaluated. Three trials were set up: (*a*) the control ration, made up of 16% crude protein; (*b*) the control ration supplemented by sprouted barley; and (*c*) the control ration supplemented by sprouted barley, oats, and wheat.

One hundred and twenty-eight weanling pigs, 3–4 wk of age, were selected and placed on the aforementioned three trials. Pigs weighing 24.91–49.83 kg received 0.9 kg of sprouted grain daily and pigs 49.83–99.66 kg received 1.36 kg of sprouted grain daily. The hogs were fed to market weight and then evaluated. There was no significant difference recorded in relation to rate of gain, feed efficiency, carcass quality, and health.

Poultry

Avoparcin as a growth promoter for turkey broilers. An experiment was conducted to test the effectiveness of the antibiotic avoparcin as a growth promotant for turkey broilers. Avoparcin at 10 mg/kg had no significant effect on mortality, efficiency of feed conversion, or percentage grade A carcasses, but liveweights at 70 and 98 days were significantly greater than those for turkeys fed diets without avoparcin.

Bioeconomic effects of feeding turkey broilers grower–finisher diet combinations differing in protein level. To evaluate the effects on performance and monetary returns of four grower and three finisher protein levels in isocaloric diets, 2400 poults of the Diamond White Strain were housed in 48 pens (13.54 m^2) and fed grower diets from 22 to 70 days of age and finisher diets from 71 to 98 days of age. Grower diets contained 20, 22, 24, and 26% protein, and finisher diets contained 14, 16, and 18% protein. Body weights of turkeys fed diets containing 22% or more protein from 22 to 70 days were significantly heavier than turkeys fed 20% protein. Diets containing 14, 16, and 18% protein were fed to turkeys between 70 and 98 days; body weights were increased by 0.15 kg for males and by 0.07 kg for females for each 1% of added protein. Feed efficiencies of the turkeys followed similar trends. The protein requirement of the Diamond White Strain of turkeys

is between 22 and 24% from 22 to 70 days, and at least 16% from 71 to 98 days. Optimum monetary indices were achieved with grower diets that have either 20 or 24% protein (metabolizable energy of 12 970 kJ/kg), coupled with finisher diets containing either 16 or 18% protein (metabolizable energy of 13 619 kJ/kg).

Comparison of rearing broilers at different stocking densities: An economic analysis. Energy costs, investment costs, and the overall cost of production of chicken and turkey broilers have escalated in the past decade. Some areas where costs can be reduced by sound managerial practices have been identified. A major study area has been the effect of reducing floor space per bird below the suggested, or cost of production average, floor area of 0.07 m^2/chicken broiler and 0.217 m^2/turkey broiler.

Traditional stocking densities for broilers should be reconsidered when an increase in broiler production is required. The experimental results and estimated budgets show that production practices different from those in the benchmark farm (boards, floor-footage recommendation) can increase returns.

Budgets demonstrate that increasing the stocking density, by reducing the floor area by 0.019 m^2/bird from the benchmark densities for broilers, would result in at least a $0.01/kg increase in returns of live meat produced and large savings in construction costs when output matches floor-space requirements.

Economic analysis of rapeseed meal and fishmeal as protein supplements in chicken broiler diets. Economic returns of chicken broilers on a diet containing soybean meal (SBM) as the primary protein source, and nine dietary regimens with various levels of rapeseed meal (RSM) and fishmeal (FM), as direct substitutes for SBM, were estimated.

Experimental performance data shows that Tower rapeseed, Candle rapeseed, or blends of RSM (that is, Canola) are competitive with soybean meal as alternate protein sources in diets fed to chicken broilers. The present analysis demonstrates that in addition to the attractive biological performance of chicken broilers on diets containing RSM, the diets simultaneously provide a superior economic return to diets using only soybean meal as the protein source.

Replacement of soybean meal in chicken broiler diets by rapeseed meal and fishmeal complementary sources of dietary protein. Two experiments were conducted to evaluate the nutritional value of *Brassica napus* 'Tower' rapeseed meal (Tower RSM) and *B. campestris* 'Candle' RSM, or combinations of Tower RSM and fishmeal (FM) or Candle RSM and FM, as partial or complete replacement for soybean meal (SBM) in chicken broiler starter and finisher diets. Amino acid levels were maintained in diets where SBM was replaced by RSM by increasing the level of FM. The results of these experiments indicate that RSM can replace up to 80% of the SBM in chicken broiler starter and finisher diets, on a straight replacement basis without adversely affecting body weight or feed efficiency. Moreover, RSM can replace all the SBM in such diets without adverse effects on biological performance, provided energy, protein, and amino acid differences are compensated. The calculated amino acid content of the diets indicates that FM is a complementary source of dietary protein in diets containing high levels of RSM.

Nutritive value and quality of oat groats for broiler chicken. Four experiments were done to ascertain the nutritive value and quality of oat groats (OG) as a partial replacement for corn and as a total replacement for wheat in practical diets for broiler chicken, using one commercial broiler genotype, Cobb. In each of experiments 1 and 2, 360 day-old chicks of each sex were housed in Petersime batteries and fed starter (1–21 days) and finisher (23–42 days) diets with Eastern (E) OG or Western (W) OG at levels of 0, 200, and 400 g/kg. In each of experiments 3 and 4, 320 day-old chicks of each sex were housed in eight floor pens and fed starter diets with EOG at levels of 0, 400, and 600 g/kg, and finisher diets with EOG at levels of 0, 400, 600, and 800 g/kg. Feeding up to an OG level of 600 g/kg in starter diets and an OG level of 800 g/kg in finisher diets had no significant adverse effect on biological performance or monetary returns.

Influence of hatching-egg size on the subsequent performance of broiler chickens. Hatching eggs were collected from two commercial meat parent genotypes (185–195 days of age) and sorted into three size groupings: (*a*) 46–50 g inclusive, (*b*) 51 and 52 g, and (*c*) 53–57 g inclusive. Eggs from groups *a* and *c* were incubated and hatched, and the broiler chicks grown to slaughter age (48 days). The chicks hatched from the smaller eggs weighed

less at 28 and 48 days than chicks hatched from the larger eggs. Mortality and feed conversion were not significantly ($P > 0.05$) affected by egg size. Small egg size resulted in reduced monetary returns that are significant ($P < 0.15$) when carcass grades were used in the calculation of meat revenues.

Effect of different dietary protein levels in a three-stage diet system on general performance of chickens reared to roaster weight. Two thousand male day-old chicks of two commercial genotypes were randomly assigned to 20 pens (13.54 m^2). The genotypes were housed separately in pens of 100 birds. Two replicate pens were each fed one of five different dietary regimens. The experiment was designed to ascertain whether roasting chickens could be reared successfully on a three-stage system and to determine the optimum level of protein to be fed during each stage. Starter diets were fed as crumbles from 1 to 21 days, whereas grower and finisher diets were fed as pellets from 22 to 49 days and 50 to 70 days, respectively. Diets within a type were isocaloric (kilojoules per kilogram of metabolizable energy): starters (12 552), growers (13 180), finishers (13 807); but differed in protein (percentage): starters (16, 18, 20, 22, 24), growers (18, 20, 22, 24), finishers (14, 16, 18). Roasters can be reared successfully on a three-stage diet system. Significant differences were observed among the dietary regimens tested for all traits measured, except for total leg abnormalities. As the protein content of starters, growers, and finishers decreased, body weights decreased, but feed conversion improved, mortality decreased, and monetary returns improved. Interactions between genotype and dietary regimens occurred for a number of traits and are discussed. From the regimens considered, a dietary regimen that included starter, grower, and finisher diets with protein (energy) levels of 16% (12 552 kJ/kg), 20% (13 180 kJ/kg), and 16% (13 807 kJ/kg), respectively, resulted in optimum biological response and monetary returns.

Performance of laying hens fed diets containing soybean gums, rapeseed gums, or rapeseed meals with and wihout gums. Two experiments were conducted to study the effect of soybean gums (SBG) or rapeseed gums (RSG) or both on general performance and mortality of laying hens. In experiment 1, 1824 single-comb White Leghorn (SCWL) hens of two commercial genotypes (912 of each) were fed either a corn–soy based control diet, or this diet to which was added 2.0% by weight of either SBG or RSG. In experiment 2, 1824 hens of the more sensitive genotype used in experiment 1 were fed a control diet, diets containing approximately 15% of gummed and gumless Tower and Candle rapeseed meal (RSM), or a gumless Tower RSM diet to which was added 3.33% Candle gums. The addition of SBG and RSG to the diet (experiment 1) caused a significant increase in mortality, increased the amount of feed required to produce a kilogram of eggs, and decreased heart and liver weights. Feeding RSM with and without the commercial level (2.0% of the RSM, or in this study 0.3% of the diet) of added gums had no effect on body weight or egg weight. Hen-housed egg production and feed per dozen eggs was significantly depressed by feeding Candle RSM with gums and by feeding gumless Tower RSM to which had been added Candle gums, indicating that Candle gums but not Tower gums are deleterious to laying hens, even at the commercial level of addition to RSM. Accumulated mortality to 497 days was significantly higher for all groups fed RSM with or without gums compared with the control fed group. The increase in mortality with this sensitive genotype appeared to be related to the mere presence of RSM in the diet and not due to the presence of gums per se. The major cause of mortality in both experiments was diagnosed as fatty liver syndrome, and from results of experiment 2 this cause appeared to be related to the presence of RSM in the diet and not caused by the presence of gums.

PUBLICATIONS

Research

Al Hassan, S.; McRae, K. B.; Hulan, H. W.; Proudfoot, F. G. 1981. A comparison of rearing broilers at different stocking densities. Can. Farm Econ. 16:19-28.

Blatt, R. 1981. Effects of nitrogen source, rate and time of application on fruit yields of the Micmac strawberry. Commun. Soil Sci. Plant Anal. 12:511-518.

Craig, D. L. Minas Snow rhododendron. Can. J. Plant Sci. 61:1023-1024.

Cumming, D. B.; Stark, R.; Sanford, K. A. 1981. The effect of an individual quick blanching method on ascorbic acid retention in selected vegetables. Food Process. Preserv. 5:31-37.

Hall, I. V.; Gourley, C. O.; Wood, G. W. 1981. Biology of *Prunus pensylvanica* L. f. Proc. N.S. Inst. Sci. 31:101-108.

Hall, I. V.; Shay, J. M. 1981. The biological flora of Canada. 3. *Vaccinium vitis-idaea* L. var. *minus* Lodd. Supplementary account. Can. Field-Nat. 95:434-464.

Herbert, H. J. 1981. Biology, life tables, and intrinsic rate of increase of the European red mite, *Panonychus ulmi* (Acarina: Tetranychidae). Can. Entomol. 113:65-71.

Herbert, H. J. 1981. Biology, life tables, and innate capacity for increase of the twospotted spider mite, *Tetranychus urticae* (Acarina: Tetranychidae). Can. Entomol. 113:371-378.

Hulan, H. W.; Corner, A. H.; Nash, D. M.; Proudfoot, F. G. 1981. Growth, heat weight, cardiac lipid and pathology of chickens fed rapeseed and other vegetable oils. Poult. Sci. 60:1670-1671.

Hulan, H. W.; Proudfoot, F. G. 1981. The effect of different dietary protein levels in a three-stage diet system on general performance of chickens reared to roaster weight. Poult. Sci. 60:172-178.

Hulan, H. W.; Proudfoot, F. G. 1981. Bio-economic effects of feeding turkey broilers grower–finisher diet combinations differing in protein level. Poult. Sci. 60:358-364.

Hulan, H. W.; Proudfoot, F. G. 1981. Effect of feeding different levels of dietary protein in grower diets and switching from starter–grower–finisher at different ages on the performance of turkey broilers slaughtered at 84 or 98 days of age. Poult. Sci. 60:603-610.

Hulan, H. W.; Proudfoot, F. G. 1981. A review of the influence of genotype and diet on the incidence of leg weakness in broiler chickens. Proc. Maryland Nutr. Conf. pp. 40-50.

Hulan, H. W.; Proudfoot, F. G. 1981. Replacement of soybean meal in chicken broiler diets by rapeseed meal and fish meal complementary sources of dietary protein. Can. J. Anim. Sci. 61:999-1004.

Hulan, H. W.; Proudfoot, F. G. 1981. Performance of laying hens fed diets containing soybean gums, rapeseed gums, or rapeseed meals with and without gums. Can. J. Anim. Sci. 61:1031-1040.

Hulan, H. W.; Proudfoot, F. G. 1981. Avoparcin as a growth promotant for turkey broilers. Can. J. Anim. Sci. 61:1067-1069.

Hulan, H. W.; Proudfoot, F. G.; Zarkadas, C. G. 1981. Nutritive value and quality of oat groats for broiler chickens. Can. J. Anim. Sci. 61:1013-1021.

Jaques, R. P.; Lang, J. E.; MacLellan, C. R.; Proverbs, M. D.; Sanford, K. B.; Trottier, R. 1981. Apple orchard tests on efficacy of granulosis virus of the codling moth, *L. pomonella*. Entomophaga 26:111-118.

Jensen, K. I. N. 1981. Hexazinone, a promising herbicide for highbush bluberries. HortScience 16:315-16.

Langille, J. E.; MacLeod, J. A.; Smeltzer, G. G.; Bubar, J. S. 1981. Finale field peas. Can. J. Plant Sci. 61:1001-1002.

Langille, J. E.; Nass, H. G.; Smeltzer, G. G.; Bubar, J. S. 1981. Animo fall rye. Can. J. Plant Sci. 61:161-162.

Lidster, P. D. 1981. Some effects of emulsifiable coatings on weight loss, stem discoloration and surface damage disorders in 'Van' sweet cherries. J. Am. Soc. Hortic. Sci. 106:478-480.

Lidster, P. D.; McRae, K. B.; Sanford, K. A. 1981. Response of 'McIntosh' apples to low oxygen storage. J. Am. Soc. Hortic. Sci. 106:159-162.

Lidster, P. D.; Sanford, K. H.; McRae, K. B. 1981. Effects of modified atmosphere storage on overwintering populations of the apple rust mite and European red mite eggs. HortScience 16:328-329.

Narasimhalu, P.; Black, W. N.; McRae, K. B.; Winter, K. A. 1981. Effects of annual rate and timing of N fertilization on production of timothy, bromegrass, and reed canarygrass. Can. J. Plant Sci. 61:619-623.

Neilson, W. T. A.; Knowlton, A. D.; McRae, K. B. 1981. Preoviposition and oviposition periods of the apple maggot, *Rhagoletis pomonella* (Diptera: Tephritidae). Can. Entomol. 113:1061-1067.

Proudfoot, F. G. 1981. Photoperiod effects on the volume, motility, and viability of spermatozoa drawn from chicken males. Can. J. Anim. Sci. 61:839-841.

Proudfoot, F. G.; Hulan, H. W. 1981. Influence of hatching egg size on the subsequent performances of broiler chickens. Poult. Sci. 60:2167-2170.

Proudfoot, F. G.; Hulan, H. W.; McRae, K. B. 1981. The effect of transferring hen eggs from turning to stationary trays after 13 to 20 days of incubation on subsequent hatchability and general performance. Poult. Sci. 60(2):302-306.

Ross, R. G.; Newberry, R. J. 1981. Timing and number of sprays of benomyl, fenarimol and other fungicides on ascospore production in *Venturia inaequalis*. Can. J. Plant Pathol. 3:173-176.

Vander Kloet, S. P.; Hall, I. V. 1981. The biological flora of Canada. 2. *Vaccinium myrtilloides* Michx. Velvet-leaf blueberry. Can. Field-Nat. 95:329-345.

Webster, D. H. 1981. Mineral composition of apple fruits. Relationships between and within peel, cortex and whole fruit samples. Can. J. Plant Sci. 61:73-85.

Miscellaneous

Craig, D. L. 1981. Strawberry cultivar reaction to pallidosis virus. Can. Plant Dis. Surv. 61:41-42.

Hall, I. V. 1981. Cranberry cultivars for the next decade. Canadex 233.

Hall, I. V.; Murray, R. A.; Blatt, C. R.; Lockhart, C. L.; Delbridge, R. W.; Wood, G. W.; Fox, C. J. S. 1981. Growing cranberries/La culture des canneberges. Agric. Can. Publ. 1282. 29/30 pp.

Hulan, H. W.; Proudfoot, F. G. 1981. Protein level in turkey broiler growing and finishing feeds. Poult. Dig. 40:326.

Jensen, K. 1981. Diclofop-methyl—A new herbicide for peas. Canadex 142.641.

Jensen, K. 1981. Guide to chemical weed control. Atl. Prov. Agric. Serv. Coord. Comm. Publ. No. 75-81. 4 pp.

Langille, J. E. 1981. Grass species for pasture in the Maritimes. Canadex 127.

Lockhart, C. L.; Lidster, P. D. 1981. Home storage room for fruits and vegetables: Construction and operation. Agric. Can. Publ. 1478.

MacPhee, A.; Paradis, R. O. 1981. Integrated pest management in apple orchards in Eastern Canada. *In* Proc. First Japan-Can. J. Symp. Integrated Pest Manage. (IPM), Moriaka, 21 October 1981. Secr. Agric., For. Fish. Res. Counc. Nat. Inst. Agric. Sci. Japan.

Proudfoot, F. G.; Hulan, H. W. 1980. New record for broiler chicken growth attained at the Kentville Research Station. Canadex 452.50.

Research Station
Fredericton, New Brunswick

PROFESSIONAL STAFF

C. S. Bernard, B.S.A., M.Sc., Ph.D.	Director
L. W. Garber, B.A., M.Ed.	Administrative Officer
D. B. Gammon,[1] M.A.	Library Area Coordinator
N. Taniguchi,[1] B.L.S.	Librarian
D. A. Young, B.Sc., M.Sc., Ph.D	Officer in Charge, Benton Ridge

Environmental Quality and Soils

T. L. Chow, B.Sc., Ph.D.	Soil hydrology
R. R. King, B.Sc., M.Sc., Ph.D.	Residue chemistry
A. A. MacLean, B.Sc., M.Sc., Ph.D.	Soil chemistry and environmental quality
G. R. Saini, B.Sc., M.Sc., Ph.D.	Soil physics

Animal Nutrition and Livestock Feeds

P. L. Burgess, B.Sc., M.Sc., Ph.D.	Dairy cattle nutrition
R. S. Bush, B.S.A., M.Sc., Ph.D.	Calf nutrition
R. E. McQueen, B.Sc., M.Sc., Ph.D.	Rumen microbiology
J. W. G. Nicholson, B.Sc., M.Sc., Ph.D.	Meat animal nutrition

Potatoes

R. H. Bagnall, B.Sc., M.Sc., Ph.D.	Virus epidemiology and resistance
G. Boiteau, B.Sc., M.Sc., Ph.D.	Potato insect ecology
M. C. Clark, B.Sc., Ph.D.	Biochemistry of disease resistance
W. K. Coleman, B.Sc., Ph.D.	Potato physiology
H. DeJong, B.A., M.S., Ph.D.	Diploid breeding and genetics of potato
W. A. Hodgson, B.Sc., M.Sc.	Late blight of potato
A. R. McKenzie, B.Sc., M.Sc., Ph.D.	Tuber-borne pathogens of potato
C. D. McLeod, B.A.Sc., M.A.Sc.	Agricultural mechanization engineering

G. C. Misener, B.Sc., M.Sc., Ph.D.	Potato harvesting and storage engineering
R. P. Singh, B.Sc., M.Sc., Ph.D.	Virus disease of potato
G. C. C. Tai, B.Sc., M.Sc., Ph.D.	Quantitative genetics of potato
T. R. Tarn, B.Sc., Ph.D.	Cytogenetics of potato
D. A. Young, B.Sc., M.Sc., Ph.D.	Potato breeding and genetics

Small Fruits

C. D. McLeod, B.A.Sc., M.A.Sc.	Agricultural mechanization engineering
G. W. Wood, B.Sc., M.A., Ph.D.	Blueberry pests

Senator Hervé J. Michaud Experimental Farm

J. M. Wauthy, B.Sc.	Superintendent; Forage and cereal crops
P. V. LeBlanc, B.Sc., B.S.A.	Vegetables
M. Luffman, B.Sc.	Fruits

---

[1]Seconded from Libraries Division, Finance and Administration Branch.

INTRODUCTION

The Fredericton Research Station conducts a comprehensive research program on potatoes, using a multidisciplinary approach on cultivar development, tuber quality, pest management, storage and dormancy, soil utilization, and handling processes. Recently, priority has been given to the seed potato sector of the industry, emphasizing the testing of Canadian genetic stocks in countries with import potential, and to aspects of phytosanitary quality.

The main emphasis of the livestock and livestock feeds program is the efficient utilization of forages by dairy and beef cattle and by sheep. Aspects of herd and flock management are also investigated. Part of the research is conducted in close collaboration with the Nappan Experimental Farm.

During the last decade, the horticultural program has consisted of research on the management of wild stands of blueberries and of some contributions to the program at the Kentville Research Station on the management of apple orchards and the evaluation of strawberry cultivars. To this horticultural involvement is now added the research at the Hervé J. Michaud Experimental Farm, established at Buctouche, N.B., in 1978. Its first research summary appears in this report.

The results reported indicate the outcome of the ongoing research programs. More complete information is available from the Research Station, Research Branch, Agriculture Canada, Box 20280, Fredericton, N.B. E3B 4Z7.

C. S. Bernard
Director

ANIMAL NUTRITION AND LIVESTOCK FEEDS

Forage quality forecast

A program was developed to advise farmers on the current and anticipated nutritional quality of forages as the crops were growing. Predictions were made each week for the following 10 days. They were based on rapid laboratory analyses and on data from forages and weather in previous years. A long-range weather forecast and hay-drying index were also included. Various media were tested for delivering the information to farmers; toll-free telephone and regular radio broadcasts were the most effective.

Silo types for the storage of timothy grass

A 3-yr study was completed to evaluate an oxygen-limiting steel silo with a conventional concrete stave silo for the storage of timothy grass. For each silo filling, first-crop timothy was cut at the early head stage of plant maturity and allowed to wilt to approximately 35% dry matter (DM) before harvesting. The resulting silages from the two silo types were fed as the sole forage to a total of 36 balanced pairs of milking cows.

The amount of timothy DM stored was less than the manufacturer's rated capacity for both silo types. With the higher capital cost of the oxygen-limiting silo, the cost per tonne of silage DM stored was sharply increased by this deficiency. Based on 3-yr means, there were no significant differences between the silo types with respect to fermentation or spoilage losses and resulting DM digestibility, feed intake, milk yield, and milk fat and protein percentages by dairy cows.

Because of the higher capital costs, similar storage losses, and lack of demonstrated advantages for animal production, oxygen-limiting silos are not recommended over concrete stave silos for the storage of timothy grass.

Grain processing and forage intake

Twelve lactating cows were used in a Latin square design to compare the effects of rolling, fine grinding, or fine grinding plus pelleting of corn- and barley-based concentrates on ad libitum grass silage intakes. Concentrate allowance was constant for all cows in each period. Corn-based concentrates gave significantly ($P < 0.1$) higher milk yields and protein percentages but lower milk fat than barley-based concentrates. Silage intake was unaffected by the kind of grain in

the rations. Fine grinding of the grains, whether fed as meal or pelleted, did not reduce silage intake or total DM intake and resulted in significantly ($P < 0.05$) higher milk yields than rolled grains.

Densely seeded corn for silage

Bird damage of corn grown for silage is a serious problem in some areas. One means of preventing loss of feed nutrients without sacrificing DM yield or production of animal products per unit area of land is to increase the density of seeding the corn. Data from the 3rd yr of a 3-yr comparison of dense (200 000 seeds per hectare) and normal (56 000) seeding rates again show higher beef production per hectare from the dense-seeded corn.

The DM yield was 13 960 kg/ha for dense-seeded corn versus 8836 kg/ha for normal-seeded corn. Grain yields were 1438 versus 1682 kg/ha or 10 versus 19% of the DM yield for the dense- and normal-seeded corns. It was estimated that birds had removed 50 and 58% of the grain from the dense- and normal-seeded corn, respectively.

The silages were fed ad libitum to fatten beef cattle, which also received a protein–mineral–vitamin supplement and rolled barley of up to 1.5% body weight. The cattle fed the dense-seeded silage gained 1.19 kg/day and those fed the normal silage 1.22 kg/day. This difference is less than observed in the first 2 yr of the trial, when the cattle were fed lower levels of grain in their diet.

Urea in calf rations

Urea can contribute a significant amount of the protein nitrogen in mature ruminant diets. However, the age at which the young ruminant can effectively utilize it has not been well documented. Fifty-six Holstein calves were assigned to either control or 2% urea rations for 84 days. The urea ration contained 2% less gross energy and 5% less total nitrogen than the control. The control calves grew significantly faster from weaning at 28 days to 84 days. However, the control calves ate significantly more feed during the same period. It is possible that the decreased consumption of the urea ration reflected poorer palatability. The difference in growth rates between the two groups could be accounted for by differences in consumption and nutrient density. Therefore urea, which accounted for about 30% of the dietary nitrogen in the urea diet, did not appear to cause any problems for newly weaned calves.

Feeding fermented colostrum to calves

It has previously been reported that calves fed fermented colostrum grow less rapidly than calves fed whole milk. Groups of calves were fed whole milk (*a*) or fermented colostrum diluted to be isocaloric (*b*), isonitrogenous (*c*), or both (*d*) with respect to the whole milk. Groups *b* and *c* grew 23 and 19% slower than group *a*. The isonitrogenous–isocaloric group was supplemented with lactose to meet either 3 or 15% of the gross energy content of the diet. Groups *b* and *c* gained 33 and 22% slower than the whole milk group. Thus, it appears that the reasons for slower growth when feeding fermented colostrum are more complex than a simple energy–protein balance.

It is also important to note that there were no health problems identified with any of these treatments. Therefore, the loss of 2 or 3 kg of growth up to weaning because of feeding fermented colostrum may be balanced by economic savings in the amount of milk sold or milk replacer not purchased during that period.

Cull potatoes in high-energy diet give most economical beef gains

Five different systems of growing and finishing beef calves were compared on the basis of net economic returns. The systems were selected from 10 that were evaluated by computer simulation. They were applied to a total of 80 spring-born, crossbred beef calves starting at weaning (6–7 mo old), when their average weight was 206 kg.

The systems included the following: (*1*) high-level feeding based on potatoes and hay; (*2*) high-level feeding based on grain and grass–legume silage; (*3*) low-level feeding on grass silage plus supplement for 100 days to gain 0.5 kg/day, then finished on silage and grain; (*4*) low-level feeding on grass silage plus supplement for 200 days to gain 0.5 kg/day, then finished on silage and grain; (*5*) low-level feeding on grass silage plus supplement for 200 days to gain 0.5 kg/day, then finished on pasture with grain as needed.

All animals were individually fed. Steers were slaughtered at 475 kg and heifers at 440 kg, provided they had sufficient fat cover for grade A1. Prices current in the fall of 1981 were used to estimate costs and returns.

Interest was charged at 20%. The number of days to reach market weight were 236, 237, 272, 315, and 343 for systems *1* to *5*, respectively.

The net returns (loss) per head for systems *1* to *5* were $49.99, 16.51, (–28.56), (–48.97), and 12.87, respectively. System *1*, including cull potatoes, gave the highest net return, even though potatoes were priced at 8.25¢ per kilogram. In many cases, they are available for less.

The revenue was least for system *5* using pasture, because these animals were slaughtered at lighter carcass weights and several failed to make A1 grade. A slight improvement in animal performance on pasture or a slight reduction in interest rate would move system *5* into second place in net economic returns. These results show that even in relatively difficult times it is economically possible to grow and fatten beef cattle using cull potatoes and pastures, which are abundant in Altantic Canada.

Potato vine silage for sheep

Previous work has shown that potato vines harvested while still green contain a useful level of nutrients for ruminant animals. When mixed with dry material such as hay or straw, they can be ensiled and are readily eaten by sheep. As harvested, green potato vines contain only 10–12% DM and do not ensile properly. An experiment was carried out to compare the nutritive value of two silages made from potato vines or potato vines plus tubers after water was removed from the material by two passes through a belt press.

The pressed material was ensiled in plastic bags inside metal drums, and each silage was fed to four sheep to determine digestibility and voluntary intake. The chemical analyses and digestibility coefficients for the potato vine silage and the potato vine plus potato tubers silage were, respectively: DM 24.9 and 27.8%; crude protein 15.3 and 10.0% of DM; soluble carbohydrate 1.4 and 30.4% of DM; ash 28.3 and 20.1% of DM; pH 5.1 and 5.0; DM digestibility 50.5 and 54.8%; crude protein digestibility 66.7 and 41.2%; organic matter 64.5 and 66.3%; and energy 61.4 and 62.6%.

All sheep developed moist feces about 1 wk after starting to receive the silages. Except for one sheep receiving the vines plus tubers silage, this condition cleared up in 2 or 3 days, and no other signs of digestive upsets or ill health were noted. The average daily DM intakes during the ad libitum feeding period were 37 and 32 g/kg of body weight for the potato vine and potato vine plus tubers silages.

Glycoalkaloid analyses showed that most of the glycoalkaloids remained in the juice, which was discarded after pressing. Only minimal amounts of intact glycoalkaloids were found in the silage. Most of the original glycoalkaloids present had been hydrolyzed to the alkaloid solanidine. A considerable proportion of the total available alkaloids consumed were present in the feces as the alkaloid solanidine and its 5,6-dihydro analogue. These results indicate that glycoalkaloid toxicity is not likely to be a problem when pressed and ensiled potato vines are fed to ruminants. No data on pesticide residues are yet available. Therefore, feeding potato vines cannot be recommended until possible pesticide accumulation is investigated.

Potato steam peel waste for pigs

The steam peeling method used in many potato processing plants generates large quantities of partly cooked potato waste. Laboratory tests on this material indicated that the proteolytic enzyme inhibitors found in raw potatoes were inactivated by the steaming. Much of the starch was also denatured, indicating that this material could be digested by animals with simple stomachs.

A digestion trial was conducted with six pigs weighing an average of 43 kg at the start. The steam peel was incorporated into a standard grower diet to supply 35.8% of the ration DM. The steam peel waste contained 11.5% DM and the DM contained 16.9% crude protein, 9.2% ash, and 3814 kcal/g. The digestibility coefficients for potato steam peel waste were as follows: DM, 81%; organic matter, 82%; crude protein, 61%; and energy, 77%.

These results indicate that potato steam peel waste is a useful feed for growing pigs. At the level of inclusion used in this trial, there was some reduction in daily feed intake compared with the standard grower. Further trials are needed to define the optimum level of inclusion in the diet. Preliminary indications are that it should not exceed about 25% of the DM.

Digestibility of poplar fermented by white rot fungi

That white rot fungi are able to degrade lignin and thereby increase the digestibility of poplar sawdust (PS) was established in preliminary laboratory in vitro experiments. *Ganoderma applanatum* was the most promising of several fungi studied. Sufficient poplar shavings were fermented with *G. applanatum* in 5-kg batches for a digestion trial with sheep. The average fermented PS dry matter composition was 81.1% neutral detergent fibre (NDF), 62.4% acid detergent fibre (ADF), and 9.0% lignin but it did not have the nutritional quality of previous small-scale fermentations. Experimental diets were made by substituting hammer-milled timothy with PS so that they had 0, 15, and 30% PS, and urea was added so that all were iso-N. The diets were fed ad libitum to four sheep in a 4 × 4 Latin square, along with 100 g of soybean–mineral supplement (45% crude protein) per day. The DM intakes, energy, and NDF digestibilities were the same for all diets. When the 15% PS diet was ground finer, the sheep consumed more while the energy and NDF digestibilities declined slightly. Diets that contained 45% fermented PS did not provide sufficient nutrients to maintain sheep. The fermented poplar shavings were nutritionally equivalent to low-quality timothy hay when fed at levels of 30% or less of the diet (contract research with Nova Scotia Research Foundation).

Enzyme extracts from rumen epithelium

To better understand the function and metabolic constraints of the rumen, the changes in metabolism from preruminant to functional ruminant are being examined.

Initially, it was important to measure the amount of enzyme activity in rumen epithelial extracts that one might expect to have originated from rumen bacteria. The specific activities (units per milligram of protein) of 10 enzymes were found to be comparable for epithelium and bacterial extracts. It was also shown that after electrophoresis of epithelial and bacterial extracts, the epithelial malate dehydrogenase had a major band that represented at least 95% of its enzyme activity and that was different from the band corresponding to the enzyme from rumen bacteria. There was little alignment also for lactate dehydrogenase. It was concluded that bacteria adhering to buffer-washed epithelium would contribute no more than 5% of the enzyme in an epithelial extract. Therefore, bacterial enzymes should not affect our attempts to partly purify and characterize certain enzymes from the rumen epithelium.

POTATOES

Breeding

New potato varieties. Three new varieties have been introduced during 1981.

Shepody is a main-crop cultivar, with haulm maturity a little earlier than Kennebec and much earlier than Russet Burbank. Tubers are long, smooth, and lightly netted. Marketable yields are significantly higher than Russet Burbank. It has excellent French-fry quality and good boil and bake qualities. It has moderate resistance to rhizoctonia, fusarium, phoma, and net vercosis but is susceptible to verticillium wilt. Shepody offers good potential as a French-fry variety for the fall and early storage season.

Caribe is an early variety with good appearance and size and an oblong shape. It is equal to Kennebec and its boiling and baking qualities are good for an early variety. It has moderate resistance to scab and potato virus Y (PVY). Caribe has performed well over a wide range of environments and because of this has potential as an export variety.

Acadia russet is a long, smooth, blocky, russet-skinned tuber with excellent appearance. It is a little later in maturity than Kennebec but has similar boiling and baking qualities. It is not suitable for potato chips or French fries. It is resistant to phoma and to potato leaf roll virus (PLRV). It is hoped that Acadia Russet can meet the need in Atlantic Canada for an attractive, good-quality, high-yielding russet.

Inheritance of sensitivity to metribuzin. A method has been developed for screening populations of potato genotypes for sensitivity to metribuzin. Plants are screened in the greenhouse by growing them in a nutrient solution containing metribuzin. Sensitivity to metribuzin was found to be determined by a single recessive gene in several classes of cultivated diploid potatoes. This gene is a potentially useful marker gene in potato genetics and may also have application in

research on photosynthesis in the potato. A preliminary screening of common tetraploid cultivars and breeding stocks also indicated a considerable variability in that material for sensitivity to metribuzin. These results have implications for the use of herbicides in the field maintenance of germ plasm collections and for potato breeding.

Flower abnormalities and sterilities in Tuberosum–Andigena hybrids. Flower abnormalities and sterilities often occur in Tuberosum × Andigena (TA) families and less often in Andigena × Tuberosum families. They are rare in Andigena and are common in Tuberosum. These abnormalities and sterilities in TA hybrids are a potential limitation to the use of this material in further breeding, and knowledge of them may have application to the production of true seed.

Male sterilities recorded include shriveled microspores, sporads, and other types with thick, sculptured walls and little or no cytoplasm. These are considerably more frequent in TA families than in other reciprocals. The expression of some forms of male sterility, especially shriveled microspores, is very sensitive to environmental changes. Developmental studies of some male sterile types show major variations in the development of the tapetum.

Studies of female sterilities have been more limited, but on the basis of field scores of the frequency of open-pollinated fruit, families with F66011 or Monona as the female parent have a low female fertility, whereas families with F64013, Raritan, Guelph selection 5280-267, F62008, or Grand Falls as the female parent have a high level of female fertility. Andigenas used as males in TA crosses appear to have less effect on the female fertility of their progeny.

Entomology

Ground arthropods in potato fields. Eleven genera of adult carabids were collected from potato fields during a 3-yr study conducted at the Fredericton Research Station. Generic and species composition did not vary substantially from year to year but abundance did. *Harpalus, Agonum, Pterostichus,* and *Carabus* were the most numerous, representing 95% of all specimens collected. Carabidae were the most abundant ground arthropods, followed by Staphylinidae and Arachnida.

The dominant species of Carabidae, *H. rufipes*, is a potentially good natural control agent. It is active early enough in the season to decrease pest populations of aphids when they are still low. Also, potato fields provide fairly stable conditions for this species, which depends on relatively bare, cultivated soil. Significantly, the peak seasonal activity of rove beetles and spiders coincides with infestations of *Macrosiphum euphorbiae* on potatoes, suggesting that they have potential as natural pest-control agents. The high activity of spiders in the woodland and at the border of the fields suggests that potato fields are colonized from the woodland. Increasing the complexity of habitat surrounding potato fields might help increase numbers of Arachnida.

This study has shown that by their relative abundance, particularly early in the season, ground arthropods may play an important role in the control of pests of potatoes. However, the more numerous spiders and carabids in field borders close to trees indicate that the size and location of fields will affect the degree of biological control that can be achieved.

Pathology

PSTV indexing by polyacrylamide gel electrophoresis. Two procedures for the extraction of nucleic acids from tissues infected with potato spindle tuber viroid (PSTV) were evaluated. A 1-day procedure consisted of homogenization in buffer–phenol–lithium chloride solution followed by precipitation of the nucleic acids with ethanol. A 2-day procedure involved homogenization of tissues in buffer–phenol mixture, addition of chloroform–amyl alcohol, precipitation of lithium chloride, overnight dialysis, and precipitation of nucleic acid with ethanol. The final detection of PSTV was by polyacrylamide gel electrophoresis (PAGE) of preparations using both extraction procedures. Both procedures were equally sensitive; however, band intensity was much stronger with the 2-day procedure. The band intensity in the 1-day procedure was improved by varying the tissue-to-buffer ratio and by reducing the amount of water in which nucleic acids were dissolved before electrophoresis. Using this procedure, the following conclusions were made: PSTV was detected more reliably from foliage than from sprouts; PSTV was detected more reliably from potato plants grown at 25°C than at 15°C; and PSTV detection was unreliable from plants that were 2–3 mo old.

Detection of PVY from primarily infected mature plants. PVY was detected in greenhouse- and field-grown potato plants (which were inoculated 7 wk after planting) by local lesion host *Solanum demissum* P.I. 230579 and by enzyme-linked immunosorbent assay (ELISA) tests. The virus was detected within 3–4 wk after inoculation in greenhouse-grown plants and 4–5 wk in the field-grown plants by local lesion hosts. Virus was detected in these same plants by ELISA 1 wk later. All plants inoculated at bottom leaf, middle leaf (halfway to the plant), or on top leaf became infected. In the greenhouse the bottom-leaf inoculated plants had a low detection rate, compared with middle- or top-leaf inoculated leaves. However, in field-inoculated plants the virus detection from leaves inoculated at various leaf positions did not differ significantly. The concentration of virus based on A405 nanometre values increased sharply in both greenhouse- and field-grown plants and then declined. The highest values were obtained in 4 wk and 6–7 wk in greenhouse- and field-grown plants. None of the plants developed visible symptoms in field-grown plants, although they were shown to be infected by both tests.

Forecasting potato late blight. Studies were continued on the development of forecast models to predict outbreaks of late blight in potatoes using only weather data available from Environment Canada. For this purpose, we used records of late blight occurrence and hourly weather data covering a 24-yr period (1953–1976). The hourly weather data included duration of rainfall, density of fog, and amount of cloud cover. Work is now in progress to determine the predictability of the models when applied to the years 1977–1981.

Physiology and crop management

Abscisic acid and tuber dormancy. Postharvest levels of free abscisic acid (ABA), a naturally occurring growth inhibitor, were monitored in tubers of the cultivars Sebago (short dormancy), Kennebec (intermediate dormancy), and Nooksack (long dormancy) during storage at 4, 10, and 20°C. Approximately 110 samples were analyzed using a modified solvent partition and gas chromatographic method.

At all three temperatures during the early postharvest period, ABA levels increased. Rate and duration of this increase (micrograms per gram of fresh weight) were proportioned to the duration of dormancy in each of the three cultivars. The highest concentrations of ABA were found in tubers stored at 4°C, whereas the lowest concentrations occurred in tubers stored at 20°C. The subsequent rates of sprout elongation at 20°C were inversely proportional to the initial ABA concentrations.

Alkyl halide effects on tuber dormancy. Alkyl halides were evaluated for their ability to reduce the duration of tuber dormancy. Bromoethane was very effective in immediately breaking dormancy and causing multiple sprouting when applied as a vapor at 0.1–0.2 mL/L for 24 h at room temperature. Tuber breakdown occurred if proper skin set had not occurred either in the field or after a curing period. During fall greenhouse trials, treated whole tubers of the cultivars Red Pontiac, Russet Burbank, Bintje, Kennebec, and Caribe emerged 40–75% earlier when compared with untreated controls. Chemicals found to be ineffective or toxic to tubers included iodoethane, 1-bromopropane, and 1-bromobutane.

Maleic hydrazide analysis. Maleic hydrazide is registered for use as a growth regulator on some food crops where it functions as a sprout inhibitor for stored produce. Because of its known mutagenic properties, maleic hydrazide has recently been slated for priority monitoring by the United States Food and Drug Administration.

Present gas–liquid chromatographic methods developed for maleic hydrazide are complex and require prior ion-exchange chromatography cleanups to avoid detector interferences from derivatized contaminants.

Characterization of a minor product from the reaction of maleic hydrazide with diazomethane indicated to us that trapping maleic hydrazide in its enedione form would provide a derivative extremely sensitive to electron capture (EC) detection. Assessment of a number of possible reactions eventually yielded one procedure that was so specific to maleic hydrazide that detector interference from derivatized contaminants would be kept to a minimum. The procedure involved oxidation of maleic hydrazide with lead tetraacetate in the presence of butadiene. This gave a near-quantitative yield of a volatile, thermally stable Diels-Alder adduct (6,9-dihydropyridazino[1,2-a]-pyridazine-1,4-dione) even on a

1-μg scale. At maximum EC detector sensitivity, 1 ng of the derivative could easily be detected. Recoveries of maleic hydrazide from fortified potato tubers averaged greater than 86%, and the lower limit of detectability was greater than 0.05 mg/kg.

A single-hill potato digger. In the course of its potato breeding program, the Fredericton Research Station grows about 40 000 plants each year, of seedling origin, each of which must be separately harvested as part of the selection process. This operation is normally done manually and is therefore labor intensive. Mechanization of the digging operation was seen as a necessary corollary to improved labor utilization in the breeding program.

The single-hill digger was designed for digging hills of potatoes spaced at 75 cm and depositing them on the soil with the vines, without mixing tubers from adjacent hills. The digging elevator bed operates at an angle of 15° and is hydraulically powered to permit maximum flexibility. Depth wheels with haulm-cutting colters are located opposite the digging share. The entire digger is three point-hitch mounted allowing quick turn around and ease of transportation.

Lots of four cultivars of potatoes were alternately planted at 75-cm spacings. Each cultivar had a different skin color or texture, which allowed quick identification of a specific cultivar. With the alternate planting, mixing of tubers between hills during harvest could be easily noted. The results from the tests indicate that no mixing between adjacent hills of potatoes occurred. Tests were conducted with a worker walking on each side of the digger in order to ensure that the haulms passed through the machine without catching. By using the digger, the harvesting crew was able to double its daily output.

Effect of preharvest treatment on moisture loss from potato tubers. Much of the weight loss of potatoes in storage occurs during the 1st wk or even days after harvest. This moisture loss occurs because potatoes have a thin and water-permeable skin and because of cuts and bruises incurred during harvesting and transportation.

A study was initiated to determine the effect of preharvest treatment on the moisture loss during the storage of potatoes grown for the seed market. Preharvest treatments included chemical top killing, rotobeating, and pulling the fines. Random blocks of potatoes were top killed and harvested at various dates. The potatoes were manually harvested and samples of 9 kg were placed in a chamber located in a controlled-temperature storage. Individual sample trays were weighed biweekly and the weight loss was calculated as a percentage of the original potato weight.

With potatoes grown for seed, top killed at an early stage of tuber growth, the time interval between the preharvest top-kill application and harvest was found to have a significant effect on the weight loss of the tubers in storage. An interval of 2–2.5 wk was required before significantly reduced weight loss could be achieved. Of the top-killing methods evaluated, pulling generally induced less tuber weight loss in storage than the chemical method, when compared at equivalent time intervals.

SOILS

Fused magnesium phosphate as a source of fertilizer phosphorus

Fused magnesium phosphate (FMP) is used as a source of fertilizer phosphorus in a number of countries and has been projected as having potential under Canadian conditions. FMP is produced by fusion of phosphate rock and magnesium silicates. The total phosphorus content is similar to that of superphosphate and in addition it contains significant amounts of calcium and magnesium.

In our initial evaluation on a Caribou loam soil (pH 4.9), FMP increased yield and P, Ca, and Mg contents of oats in a greenhouse experiment. Nevertheless, it was relatively ineffective as compared with an equivalent ratio of P supplied by superphosphate or diammonium phosphate.

A subsequent phase of the investigation evaluated the influence of soil pH on the performance of FMP. Phosphorus was supplied by FMP or superphosphate to soils that had been limed to give a series of pH levels ranging from 4.9 to 7.8. Soil pH had no effect on the capacity of FMP to supply plant-available phosphorus. Response to FMP, as measured by yield of oats and P uptake by the plant, was low at all pH levels and less than 50% of that resulting from equivalent applications of P from a superphosphate source.

A third phase of this study related to influence of degree of fineness of FMP on its effectiveness as a source of P for plants. With the original material, 100, 55, 11, and 2% passed through 10, 40, 80, and 200 mesh

sieves, respectively. A sample of FMP was ground to give a range of particle sizes varying from 1–2 min to less than 75 μm. The capacity of the product to supply P increased as size of fertilizer granule decreased. At a particle size of less than 75 μm yields were comparable to those obtained with superphosphate. This component of the investigation indicates a possible role for FMP in crop production. This, in turn, will be dictated by the ease of overcoming difficulties associated with soil application of such a finely ground product and possibly by economic considerations as well.

Hydrologic characteristics of peat materials

Bulk densities measured on 15 cm of relatively undisturbed soil cores compared closely with that of Macaulay sampler (R^2 = 0.8). Moisture characteristic results show that undecomposed peats contain a much higher proportion of pores >29 μm that permit rapid movement of water at saturation (K_s) and are easily drained at high matric potential (ψ_m). The finer pores of the more decomposed peat permit only limited K_s and retain much more water at lower ψ_m. These results also indicate that the botanical origin of peat materials plays an important role on moisture retentivity. Significant linear and curvilinear relationships are found for the regression of water yield on both bulk density and Von Post scale of decomposition with R^2 of 0.6 and 0.8, respectively. The log K_s also correlates fairly well with percentage of macropores, bulk density, and Von Post scale of decomposition, with R^2 of 0.6–0.8.

Evaluation of soil amendments for livestock feed production

Peat moss, sawdust, and manure were incorporated as soil amendments into the subsoil of test plots. Yield data show that an increase of 12, 27, 35, and 417% were found for the loosened subsoil, loosened subsoil plus peat, loosened subsoil plus sawdust, and loosened subsoil plus manure over the control, respectively. The high increase in yield of the manure treatment may be a result, in part, of the nutrient content of the manure. Continuous monitoring of temperature of soil depths of 5, 15, 30, and 70 cm during October showed no significant difference between treatments at all depths (within ±1°C). Similarly, the variations in average surface soil-moisture content were within 0.05 g per gram between treatments. However, the matric soil-water potential of the subsoil in the control were much higher as compared with the organic treatments.

SMALL FRUITS

Blueberry pest management

The feasibility and economic advantages of a pest monitoring program for lowbush blueberry are being assessed. There are over 12 000 ha of managed stands of native blueberry in the Maritime Provinces and generally they do not require any insecticide treatment. However, they are host to a large number of insect species, some of which have the potential of causing almost complete crop loss, and regular surveillance for insect outbreaks is encouraged.

During the past 2 yr, 60 commercial blueberry fields in New Brunswick were examined and several important infestations were identified. The most serious pests were the blueberry flea beetle, *Altica sylvia* Mall., and a sawfly, *Neopareophora litura* Klug. Timely application of insecticide and successful control of these two species prevented a major crop loss on about 80 ha of blueberry land. In addition, the monitoring activity has heightened grower awareness of insect problems and has created an opportunity for developing a more effective pest management program.

SENATOR HERVÉ J. MICHAUD EXPERIMENTAL FARM BUCTOUCHE, N.B.

Plastic mulches

Various systems were tested during 1980 and 1981 on an array of horticultural crops. The effects were consistently beneficial, as indicated in the three trials herein reported.

Tomatoes. In 2 yr of testing, the use of black plastic mulch and of plastic row crop tunnels gave higher earlier yield and higher total yield of transplanted tomatoes (cultivar Early Girl) than the check plot. In 1980, the total yields were 53% higher with row crop tunnels and 49% higher with black plastic mulch. The cold weather delayed the ripening of the tomatoes in the check plot and resulted in a lower than normal yield. In 1981, the total yields were 50% higher with row crop

tunnels and 37% higher with black plastic mulch than the check plot. The growing conditions were more favorable than in 1980, and therefore the difference between plastic treatments was not as pronounced. Also, 1981 transplantation was later than in 1980 by 10 days. Thus the plants did not benefit as much from the early-season effects of the plastic materials.

Sweet corn. In 1981, the use of a clear plastic mulch resulted in 10–14 days earlier maturity of three sweet corn varieties. Yields of marketable ears were not improved significantly by the use of plastic materials. There was no interaction between varieties and plastic mulches.

Pickling cucumbers. With black plastic mulch, the average germination of six cultivars was 68% compared with 23% for the ordinary planting system. The plastic mulch warms up the soil so that there is less seed and root rot as compared with the bare-ground treatment. The yields of the pickling cucumbers under the two treatments were affected proportionately.

PUBLICATIONS

Research

Burgess, P. L.; Nicholson, J. W. G.; Grant, E. A. 1981. Effect of level of alfalfa pellets on intake of early and late harvested timothy silages of different dry matter content. Can. J. Anim. Sci. 61:633-638.

Bush, R. S.; McQueen, R. E.; Nicholson, J. W. G. 1981. Effect of fermentation and formalin preservation on the protein component of bovine colostrum. J. Dairy Sci. 64:1695-1699.

Bush, R. S.; Nicholson, J. W. G.; McIntyre, T. M.; Calder, F. W. 1981. The effect of sodium bicarbonate, cement kiln dust and ammonium perchlorate on the growth of lambs. Can. J. Anim. Sci. 61:424-428.

DeJong, H. 1981. Inheritance of russeting in cultivated diploid potatoes. Potato Res. 24(4):309-313.

DeJong, H.; Tai, G. C. C.; Russell, W. A.; Johnston, G. R.; Proudfoot, K. G. 1981. Yield potential and genotype–environment interactions of tetraploid–diploid (4x–2x) potato hybrids. Am. Potato J. 58:191-199.

Hall, I. V.; Gourley, C. O.; Wood, G. W. 1981. Biology of *Prunus pennsylvanica* L. F. Proc. Nova Scotia Inst. Sci. 31:101-108.

Kemp, J. G.; Misener, G. C.; Melanson, B. A. 1981. Prediction of latent evaporation using hourly meteorological data. Can. Agric. Eng. 23(1):45-47.

King, R. R.; McQueen, R. E. 1981. Transformations of potato glycoalkaloids by rumen microorganisms. J. Agric. Food Chem. 29:1101-1103.

Misener, G. C.; Everett, C. F. 1981. Vine pulling as a means of top killing potatoes. Am. Potato J. 58:103-109.

Nicholson, J. W. G. 1981. Nutrition and feeding aspects of the utilization of processed lignocellulosic waste materials by animals. Agric. Environ. 6:205-228.

Paliwal, Y. C.; Singh, R. P. 1981. Cytopathological changes induced by potato spindle tuber viroid in *Scopolia sinensis*. Can. J. Bot. 59:677-682.

Singh, R. P.; McDonald, J. G. 1981. Purification of potato virus A and its detection in potato by enzyme-linked immunosorbent assay (ELISA). Am. Potato J. 58:181-189.

Tarn, T. R.; Adams, J. B. 1981. Aphid probing and feeding, electronic monitoring, and plant breeding. *In* K. F. Harris and K. L. Maramorosch, eds. Pathogens, vectors, and plant diseases: Approaches to control. Academic Press, New York.

Miscellaneous

Boiteau, G. 1981. Colorado potato beetle, *Leptinotarsa decemlineata* (Say) on potato. Can. Agric. Insect Pest Rev. 1980:25-26.

Boiteau, G. 1981. Persistence of mineral oil sprays on potatoes. Canadex 631.

Nicholson, J. W. G. 1981. Utilization of forages in Eastern Canada. Proc. Natl. Forage Symp. Ottawa, Nov., 1981.

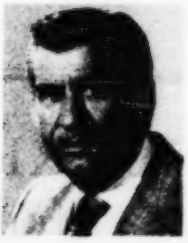
Singh, R. P. 1981. Viroids and their possible danger to potato crop in hot climates. Proc. Int. Symp. on Potatoes in Hot Climates, Herzlia, Israel. May 1981. GR1-2.

Singh, R. P.; Fernow, K. H. 1981. Potato spindle tuber viroid. Pages 89-90 *in* W. J. Hooker, ed. Compendium of potato diseases. Am. Phytopathol. Soc. St. Paul, MN.

Wood, G. W. 1981. Lowbush blueberry production. Agric. Can. Publ. 1477. pp. 20-28.

Wood, G. W.; Fox, C. J. S. 1981. Growing cranberries. Agric. Can. Publ. 1282/E (Revision). pp. 23-27.

QUEBEC REGION
RÉGION DU QUÉBEC



Mr. J.-J. Jasmin

Dr. R. Bouchard

Mr. J. R. Frappier

EXECUTIVE OF THE QUEBEC REGION
L'EXÉCUTIF DE LA RÉGION DU QUÉBEC

Director General
Directeur général
J.-J. JASMIN, B.Sc. (Agr.), M.Sc.

Program Specialist
Spécialiste en programmes
R. BOUCHARD, B.A., B.S.A., M.Sc., Ph.D.

Chief, Administration
Chef, administration
J. R. FRAPPIER, B.A.

PRÉFACE

La région du Québec, dont l'administration centrale se trouve dans la ville de Québec et qui doit déménager en 1982 à Montréal, compte trois stations de recherche et trois fermes expérimentales. Ces établissements ont pour mandat de desservir l'ensemble de l'industrie agricole du Québec et de contribuer à l'effort national en recherche et développement. En 1981, le budget de la région était de 13,3 millions de dollars avec un personnel de 76 chercheurs et un effectif total de 333 années/personnes. La décision de restructurer au niveau ministériel les finances et l'administration, et de régionaliser les bureaux à Montréal a eu un impact sérieux et momentané sur les opérations du bureau régional de la recherche.

L'agriculture de la région repose en grande partie sur les productions animales et son potentiel de production fourragère oriente l'évolution de ces industries. Il y a présentement une augmentation constante des productions céréalières et horticoles. Cependant, la production laitière demeure la plus importante au Québec, tandis que la production porcine occupe le deuxième rang dans la région et le premier au niveau national.

Les différents établissements de la région du Québec poursuivent des programmes de recherche axés sur les priorités du Ministère et tout en répondant aux besoins de la région. Ces programmes portent sur la productivité des sols de la région, les cultures céréalières, fourragères, horticoles et celles dites de grande culture, comme le tabac, les productions animales incluant le troupeau laitier, le veau de remplacement, le veau d'embouche, le boeuf de boucherie, le porc, le mouton ainsi que d'autres animaux. La recherche à contrat permet d'étudier divers problèmes allant du lait de chèvre à la culture des bleuets en passant par la qualité de la viande entreposée dans différentes atmosphères modifiées.

On a publié des travaux sur la valeur agronomique des fumiers ainsi que sur les effets polluants de l'azote, du phosphore et de la potasse dans les eaux de la rivière Saint-François. Dans le domaine de la fixation biologique de l'azote, on a cueilli dans l'Arctique des légumineuses à haute teneur en protéines et qui fixent l'azote à près de 0°C. Des données nouvelles ont démontré que les sols organiques non protégés avaient un taux d'affaissement moyen de 4,53 cm/année contrairement aux données antérieures de 2,07 cm/année. Les sols protégés ont un taux moyen d'affaissement d'environ 1 cm/année. La teneur en fer du lamina de la feuille du tabac a été associée à la maladie physiologique appelée »tabac gris«.

Dans le domaine de l'industrie animale, l'importation d'un petit troupeau de moutons Romanov de la France a très bien réussi et les sujets sont en très bonne santé dans leur lieu de quarantaine à la station de recherche de Lennoxville. Les travaux sur la race D.L.S. et ses croisements avec le Finnois ont démontré que le D.L.S. avait des caractères génétiques qui présentent un plus haut taux de fréquence de chaleur que les autres races.

Les travaux de recherche sur les plantes ont amené l'homologation du blé Mondor et de l'avoine Shaw. Des conditions hivernales très défavorables dans la région du Québec ont permis de démontrer la rusticité et la supériorité du porte-greffe nanisant du pommier Ottawa-3 et des lignées de la McIntosh à lambourdes sur la McIntosh ordinaire. La lignée du mycorhize *Glomus epigaeus* du frêne a favorisé l'absorption du phosphore chez le clone M-7 du pommier. Un appareil capable de dénombrer les spores de repos du *Plasmodiophore brassicae* extraites de tissus de crucifères a été mis au point. On a également démontré que la résistance du chou à la population 16/02/31 (race 2) de *P. brassicae* est dominante et monogénique.

Les programmes de recherche réalisés à nos diverses stations sont intégrés aux programmes de recherche à contrat qui soutiennent l'effort régional. La recherche à contrat permet à l'industrie agricole et para-agricole de s'engager dans le secteur de la recherche et du développement, et de prendre en main la solution de leurs problèmes technologiques.

Pour de plus amples renseignements, s'adresser à: Agriculture Canada, Direction générale de la recherche, 1254 rue Bishop, Montréal, Québec H3G 2E3.

J.-J. Jasmin

PREFACE

The Quebec Region, with headquarters now in Quebec City but moving to Montreal in 1982, comprises three research stations and three experimental farms. These establishments are designed to serve Quebec's agriculture industry and to contribute to national research and development. In 1981, the Region's budget amounted to $13.3 million. Scientific personnel numbered 76 researchers out of a total 333 person-years. The decision to restructure finances and administration at the Departmental level and to regionalize the offices in Montreal seriously affected operations of the regional office for a brief period.

Agricultural activity in the Region is based mainly on livestock production. The development of this industry is dictated by the Region's forage production potential. The production of cereal and horticultural crops is constantly increasing. Dairy production is the leading agricultural industry in Quebec. Hog production ranks second in the Region, and Quebec stands first in this area on a national scale.

The various establishments of the Quebec Region pursue research programs based on Departmental priorities and the Region's needs. These programs focus on the productivity of the Region's soils; development of cereal crops, forage crops, horticultural crops, and field crops such as tobacco; and improvement of the production of livestock including the dairy herd, replacement calves, feeder calves, beef cattle, swine, sheep, and other animals. Through contract research a wide range of problems are studied, including those associated with goat's milk, the growing of blueberries, and the quality of meat stored in various modified atmospheres.

Studies were published on the agronomic value of fertilizers and the polluting effects of nitrogen, phosphorus, and potassium in the waters of the Rivière Saint-François. To advance studies on the biological fixation of nitrogen, high-protein legumes that fix nitrogen at a temperature of close to 0°C were collected in the Arctic. Unprotected organic soils were newly shown to have an average rate of subsidence of 4.53 cm/yr. This rate contrasts with the 2.07 cm/yr that earlier data showed. Protected soils have an average subsidence rate of approximately 1 cm/yr. The iron content of the lamina of the tobacco leaf was found to be associated with the physiological disease known as gray tobacco.

In livestock studies, a small flock of Romanov sheep were successfully imported from France and the animals are in excellent health in quarantine at the Lennoxville Research Station. Work with the DLS breed and its crosses with the Finnish showed that the genetic traits of the DLS exhibited a higher rate of heat frequency than those of other breeds.

Research work on plants led to the licensing of Mondor wheat and Shaw oats. Highly unfavorable winter conditions in the Quebec Region demonstrated the hardiness of the Ottawa-3 dwarfing apple rootstock and spur-type McIntosh and their superiority to the regular McIntosh. The mycorrhiza strain *Glomus epigaeus* of ash favored the absorption of phosphorus in apple clone M-7. An apparatus capable of counting the rest spores of *Plasmodiophora brassicae* extracted from crucifer tissues was developed. It was also shown that the cabbage's resistance to population 16/02/31 (Race 2) of *P. brassicae* is dominant and monogenic.

The research programs carried out at our various establishments are integrated with contract research programs that contribute to the regional effort. The contracting of research allows the agricultural and para-agricultural industry to become involved in research and development and to help find solutions to their technological problems.

The personnel of the regional office may be reached by contacting Agriculture Canada, Research Branch, 1254 Bishop Street, Montreal, Que. H3G 2E3.

J.-J. Jasmin

Station de recherche
Lennoxville, Québec

CADRES PROFESSIONNELS

Administration

Y. MARTEL, B.A., B.Sc. (Agr.), Ph.D.	Directeur
H. ROULEAU	Services administratifs
R. BOULANGER	Services administratifs (intérimaires)
J. DE LÉSÉLEUC	Services administratifs (intérimaires)

Soutien scientifique

S. GAGNÉ-GIGUÈRE[1]	Bibliothèque

Production de viande

J.J. DUFOUR, B.Sc. (Agr.), M.Sc., Ph.D.	Chef d'objectifs; physiologie de la reproduction
A.M.B. DE PASSILLÉ, B.Sc., M.Sc.	Éthologie—porcs
M.H. FAHMY, B.Sc. (Agr.), M.Sc., Ph.D.	Génétique—moutons
P. FLIPOT, B.Sc. (Agr.), M.Sc., Ph.D.	Nutrition—bovins
G. LALANDE, B.A., B.S.A.	Régie—bovins de boucherie

Production laitière

G.L. ROY, B.S.A., M.Sc., Ph.D.	Chef d'objectifs; génétique
B. LACHANCE, B.Sc. (Agr.), M.Sc.	Nutrition—jeunes ruminants
G. PELLETIER, B.Sc. (Agr.), M.Sc., Ph.D.	Physiologie

Production fourragère et sols

J.-L. Dionne, B.A., B.Sc. (Agr.), Ph.D.	Chef d'objectifs; fertilité des sols
G.M. Barnett, B.Sc. (Agr.), M.Sc.	Régie—environnement
W. Mason, B.Sc. (Agr.), M.Sc., Ph.D.	Régie—plantes fourragères
A.R. Pesant, B.Sc. (Agr.), M.Sc.	Physique des sols

Départs

G. Lalande, B.A., B.S.A. À la retraite, décembre 1981	Régie—bovins de boucherie
H. Rouleau	Services administratifs

ÉTUDIANTS

J. Bernier, B.Sc. (Agr.)	Régie—boeufs
C. Farmer, B.Sc. (Agr.)	Régie—porcs
C. Girard, B.Sc. (Agr.), M.Sc.	Nutrition—jeunes ruminants
L. Guilbault, B.Sc., M.Sc.	Physiologie de la reproduction
J. Matte, B.Sc. (Agr.), M.Sc.	Nutrition—porcs
D. Petitclerc, B.Sc., B.Sc. (Agr.), M.Sc.	Physiologie de la lactation
S. Pommier, B.Sc., M.Sc.	Spécialiste en viande
N. St-Pierre, B.Sc., (Agr.), M.Sc.	Analyse de systèmes
C. Vinet, B.Sc. (Agr.), M.Sc.	Nutrition—bovins laitiers

[1]Détaché de la Direction générale des affaires financières et administratives, Division des bibliothèques.

INTRODUCTION

La station de recherche de Lennoxville et sa ferme expérimentale forment un tout visant à solutionner les problèmes les plus importants au Québec dans les domaines des productions animales, des plantes fourragères et des sols. En 1980, les programmes de recherche ont été placés sous trois objectifs: la production des viandes qui inclut les travaux sur les bovins de boucherie, le porc et le mouton, la production laitière et la production fourragère et les sols. En plus de poursuivre les travaux déjà en cours, la station a relancé les projets de recherche sur le veau lourd, la reproduction des truies et la valeur agronomique du fumier.

On peut obtenir des renseignements plus complets en écrivant directement aux chercheurs à l'adresse suivante: Station de recherche, Agriculture Canada, C.P. 90, Lennoxville, Québec, J1M 1Z3.

Yvon Martel
Directeur

PRODUCTIONS ANIMALES

Bovins laitiers

Le gras protégé ou non protégé dans les concentrés pour veaux mâles laitiers alimentés au lait entier ou au succédané du lait. Soixante veaux mâles, noirs et blancs, de type laitier, dont le poids de départ était de 46,5 kg ont été alimentés jusqu'au poids de 136,8 kg avec un des cinq régimes suivants: (*1*) lait, (*2*) concentré, (*3*) concentré avec un ajout de 3% de gras animal, (*4*) concentré avec un ajout de 3% de gras protégé, (*5*) concentré avec un ajout de 6% de gras protégé. Durant les cinq premières semaines, une moitié des veaux a reçu du lait entier tandis que l'autre moitié a reçu un aliment d'allaitement commercial. Subséquemment, tous les veaux du régime *1* ont reçu du lait entier et les veaux du régime *2*, *3*, *4* et *5* uniquement des concentrés. Trois périodes de collection, commençant au jour 27, 47 et 82, ont permis de déterminer la digestibilité apparente du lait tandis que celle des concentrés a été faite au cours des périodes commençant au jour 47, 82 et 103. On constate que la valeur nutritionnelle de l'aliment d'allaitement est inférieure à celle du lait entier lorsqu'on considère la digestibilité apparente de la matière sèche (95,8% contre 92,4%), de la protéine brute (94,1% contre 86,2%), de l'énergie brute (95,8% contre 92,0%) et du gras (96,0% contre 87,6%). Cette infériorité se reflète sur le taux de croissance, la consommation de matière sèche, l'efficacité alimentaire et l'état de santé de tous les veaux au cours des 35 premiers jours de l'expérience. À l'abattage, la supériorité du lait entier n'est plus perceptible.

Le gain quotidien des veaux du régime *1* est supérieur ($P < 0,01$) à celui des veaux du régime *2* (0,89 kg contre 0,77 kg). L'addition de gras protégé ou non protégé n'a pas d'effet significatif ($P < 0,05$) sur le taux de croissance, l'âge à l'abattage, la consommation totale de matière sèche, l'efficacité alimentaire, la consommation totale et l'efficacité de la protéine brute.

Bovins de boucherie

Effet des dates de coupe des fourrages sur le comportement chimique et sur les performances zootechniques. Nous avons mesuré, durant deux années consécutives, l'effet du stade de maturité des fourrages sur la composition chimique et sur les performances zootechniques. Ces fourrages étaient conservés secs ou demi-secs (40% de matière sèche). La première année, les fourrages ont été récoltés à la mi-juillet (pleine floraison), fin juillet (graine) et mi-septembre (deuxième coupe début épiaison). Nous avons distribué ces fourrages à 72 taurillons Hereford pesant en moyenne 250 kg. La deuxième année, les dates de coupe étaient les suivantes: mi-juin (épiaison), fin juin (début floraison), mi-juillet (pleine floraison) et fin juillet (graine). Nous avons offert ces fourrages à 96 taurillons Hereford pesant en moyenne 221 kg. En plus des fourrages, chaque taurillon recevait quotidiennement 2 kg de concentré dosant 14% de protéines. Sous des conditions normales de fenaison, l'azote et la digestibilité de la matière sèche diminuaient lorsque la maturité avançait. Les effets néfastes de la pluie équivalaient à une augmentation d'un mois de

maturité pour des fourrages récoltés à l'épiaison. Dans le premier essai, l'azote soluble et l'azote ammoniacal n'ont pas été influencés par le degré de maturité. Dans le deuxième essai, l'azote soluble diminuait au fur et à mesure que la maturité des fourrages avançait. L'azote ammoniacal est plus élevé seulement dans l'ensilage récolté à la mi-juin. La production d'acide lactique dans les ensilages variait d'une année à l'autre et l'effet de la maturité différait aussi d'une année à l'autre. Plus les fourrages étaient mûrs, plus les performances zootechniques (croît journalier et efficacité alimentaire) diminuaient. Les méthodes de conservation des fourrages n'ont pas eu d'effet sur les performances zootechniques. Par contre, l'addition de concentré a permis d'améliorer ces performances lorsque les animaux étaient nourris avec des fourrages récoltés à maturité.

Porcs

Description des changements du tube digestif de la truie primipare au cours d'un cycle de reproduction. Des changements anatomiques, physiologiques et biochimiques importants du tube digestif ont déja été observés au cours d'un cycle de reproduction chez la femelle de différents mammifères et pourraient, selon les nutritionnistes, être un facteur important dans l'utilisation des aliments et la productivité de la truie. Dans une première étape, nous avons voulu déterminer si les changements qui affectent le tube digestif de la truie au cours d'un cycle de reproduction sont aussi importants que ceux observés chez les mammifères de plus petite taille. On prévoyait qu'il serait possible ensuite de relier ces changements à la capacité digestive et à la productivité de la truie. Ces connaissances permettraient une formulation plus appropriée des rations afin qu'elles répondent mieux aux exigences nutritives de l'animal tout au cours du cyle de reproduction. L'objectif poursuivi était donc de décrire les changements anatomiques, physiologiques et biochimiques du tube digestif de la truie au cours de la gestation, de la lactation et de la période post-sevrage.

Quatre-vingt-quatre truies primipares d'un croisement d'un mâle Yorkshire et d'une femelle Landrace ont été utilisées. Six truies témoins non accouplées et six truies accouplées ont été abattues lorsque ces dernières avaient atteint 30, 70 et 110 jours de gestation, 7, 14 et 28 jours de lactation et 11 jours de post-sevrage. La même moulée a été offerte aux deux groupes de truies. Les truies accouplées ont été nourries selon un plan d'alimentation couramment utilisé par les producteurs alors que les truies vierges ont reçu 2,7 kg de moulée par jour durant toute la durée de l'expérience. Le poids des truies pesées aux quatorze jours et la consommation individuelle et quotidienne des aliments ont été recueillis. Le poids des viscères totaux et des viscères dégraissés de l'estomac, du pancréas et du duodénum ont été mesurés. L'acide ribonucléique (A.R.N.), l'acide désoxyribonucléique (A.D.N.) et la protéine totale ont été mesurés dans les muqueuses de l'estomac et de l'intestin et dans le pancréas. La pepsine de la muqueuse gastrique, l'amylase et la chymotrypsine du pancréas ainsi que la maltase de la muqueuse duodénale ont été mesurées.

Les résultats obtenus indiquaient que: le poids des viscères totaux en grammes par kg de poids vif corrigé en fonction du poids des embryons et des mamelles était semblable, au cours de la gestation, pour les deux groupes de truies, mais il était plus élevé chez les truies accouplées que chez les truies témoins durant la lactation; le poids du pancréas dégraissé avait diminué à la fin de la gestation. Par contre, les poids des tissus dégraissés de l'estomac et du duodénum n'avaient pas varié d'une façon significative au cours du cycle de reproduction; l'activité totale de la pepsine par poids corporel n'était pas différente chez les deux groupes de truies durant la gestation mais elle avait doublé chez les truies en fin de lactation comparativement aux truies témoins. Les activité totales d'amylase et de chymotrypsine ont eu tendance à diminuer en fin de gestation et à augmenter au cours de la lactation; les paramètres biochimiques mesurés sur les pancréas avaient démontré une hypertrophie au cours de la lactation et une hypertrophie du tissu à la période du post-sevrage.

En résumé, des changements anatomiques et physiologiques du tube digestif de la truie primipare apparaissent au cours d'un cycle de reproduction. Ces changements sont cependant moins importants que ceux observés chez d'autres mammifères. L'influence de la taille de la portée et de la parité sur les changements du tube digestif de la truie et la relation entre ces changements, la digestibilité des aliments et la performance des truies seront déterminées dans une expérience présentement en cours.

Les rapports entre le comportement et la mortalité des porcelets. Malgré les plus récentes améliorations apportées aux équipements et aux bâtiments, l'industrie porcine souffre toujours d'un taux de mortalité au prévesrage qui atteint 20 à 25% et même plus. Par le passé, on a décrit les causes directes des mortalités, telles la maladie (congénitale et infectieuse), l'écrasement, la régie (froid, pertes de sang par le cordon), les traumatismes de la mise bas et la malnutrition. Le but de cette étude était d'identifier les facteurs et les causes qui prédisposent à la mort, c'est-à-dire le premier maillon de la chaîne ou l'élément catalyseur qui limite les chances de survie.

Les six truies Landrace utilisées dans cette étude ont donné des portées de 7 à 10 porcelets et n'avaient aucun problème sérieux de maladie ou de comportement. De la naissance à 10 jours d'âge, un porcelet est mort dans chacune de ces portées. Ce faible taux de mortalité (12%) s'explique par l'absence de maladie et la taille moyenne ($x = 8,3$) des portées étudiées. Les comportements furent observés durant les huit premières heures de vie de chaque porcelet.

Les porcelets du groupe mortalité (qui sont morts entre 0 et 10 jours) étaient en général plus légers à la naissance, les intervalles entre les naissances étaient plus longs ($P < 0,01$) et ils étaient nés vers la fin de la mise bas. On remarque souvent que les porcelets moins lourds à la naissance sont plus faibles. De plus, un porcelet, né vers la fin de la mise bas et/ou après un long intervalle de naissance (30 min), a plus de chance d'être asphyxié ou affaibli. Ainsi, les porcelets du groupe mortalité étaient défavorisés dès le départ. Toutefois, ceux-ci ont été aussi rapides que les autres à obtenir leur première tétée et ils se sont battus (total du nombre et de la durée des batailles) autant que les autres, indiquant qu'ils étaient actifs et prêts à se battre à la naissance. Malgré cela, leur désavantage se signalait par leur taux plus faible de succès dans les batailles ($P < 0,05$) et leur tendance à téter moins fréquemment. Cette situation affaiblit le porcelet parce qu'en partant il obtient moins de colostrum (par conséquent moins d'immunoglobulines) et d'énergie.

L'étude de chacun des cas révèle une mortalité intrapartum; deux porcelets écrasés, l'un parce qu'il était faible, l'autre parce que la truie était nerveuse. Les trois autres porcelets sont morts de faim; deux d'entre eux n'ont jamais réussi à téter régulièrement et le troisième n'a plus tété après le jour 5 et il est mort au jour 7. La compétition aux tétines peut limiter le nombre de montées de lait tétées pour certains porcelets. Un tel insuccès représente le premier maillon menant à la mort pour trois porcelets, ceci même si les portées étaient de taille moyenne. D'autre part, l'anxiété de la truie a probablement influencé la mortalité intrapartum et a été la cause d'un des écrasements.

Dans une septième portée, où le taux de croissance était faible, 5 des 13 porcelets sont morts avant 10 jours d'âge. Deux sont mort-nés et les trois autres sont morts de faim au jour 7. Cette truie n'allaitait pas bien puisqu'elle souffrait de mammite. Conséquemment le taux de bataille est demeuré élevé pendant plusieurs jours contrairement aux portées bien allaitées où les batailles diminuent beaucoup après le jour 1. Les 3 porcelets morts à 7 jours d'âge étaient désavantagés dès leurs premières heures de vie. De plus, ils ont continué à se battre pour deux glandes qui s'asséchaient sans jamais chercher à téter une glande non utilisée. L'adoption les aurait certainement sauvés. La santé de la truie peut donc être un facteur qui augmente la compétition et réduit la survie des porcelets.

En conclusion, ces résultats illustrent l'importance des premières heures de vie pour les porcelets. Une bonne partie des pertes au prévesrage peuvent être évitées si on s'assure que les porcelets ont tous obtenu assez de colostrum, qu'ils continuent à téter régulièrement et qu'ils ont chaud. Lorsqu'un porcelet ne réussit pas à téter, il s'affaiblit puis meurt de faim, d'une maladie ou se fait écraser. Les progrès en régie de synchronisation de l'oestrus et des mises bas permettent au producteur de planifier plusieurs mises bas quotidiennes pour qu'elles surviennent durant le jour. Il est donc de plus en plus facile d'être présent à la mise bas afin de s'assurer que les porcelets tètent tous et que les adoptions nécessaires sont faites. Plusieurs porcelets sont asphyxiés par le processus de mise bas et il faudra trouver des moyens de réduire ces pertes. Le confort de la truie y est peut-être pour quelque chose.

Moutons

Activité ovarienne des brebis D.L.S. pendant l'été. La majorité des races de brebis passent par une période d'activité sexuelle réduite durant les chauds mois d'été. Chez

certaines races, cette activité peut cesser complètement et la brebis commence alors une période d'infertilité. Au Québec, la race D.L.S. représente un secteur en expansion où l'on vise la prolongation de la saison d'agnelage. Les brebis sont sélectionnées à partir d'une population moitié Dorset, un quart Leicester et un quart Suffolk d'après leurs performances durant les mois d'été. Elles sont accouplées aux béliers le 1 juin de chaque année et leurs dates d'agnelage sont enregistrées. Les béliers issus de la première portée des brebis sont utilisés par la suite pour l'élevage. Une population non sélectionnée, servant comme témoin, a été maintenue pour établir les changements génétiques apparaissant dans le groupe sélectionné. Les béliers de cette population témoin avaient été choisis au hasard. Le but de cette étude est de rendre compte de la présence d'ovulation, observée de mai à septembre, dans le groupe de moutons sélectionnés comparativement au groupe témoin.

Cent une brebis sélectionnées et soixante-deux brebis témoins furent abattues à partir du 9 mai jusqu'au 29 août inclusivement. Cinquante brebis du groupe sélectionné en 1974 ont agnelé en 1976, 1977 et 1978. D'après leurs performances d'agnelage, elles se sont classées parmi les meilleures du groupe de naissance (S.S.). Les autres (51) brebis sélectionnées, nées en 1975, ont agnelé en 1977 et 1978. Elles se sont classées inférieures à la moyenne de leur groupe de naissance (S.I.). Les brebis du groupe témoin ont été choisies au hasard d'après leur date de naissance. Pour les années de naissance 1974 et 1975, on a eu 35 et 27 brebis, respectivement, qui ont eu des agnelages les mêmes années que les brebis sélectionnées. Du 9 mai 1979 et, durant 16 semaines de suite, 10 brebis, dont 6 du groupe sélectionné et 4 du groupe témoin, furent abattues et leurs ovaires furent prélevés. Le poids des ovaires intacts, le nombre de corps jaunes et le nombre de corps albicans, le diamètre du plus gros follicule et du second plus gros furent enregistrés. Selon qu'il y avait ou non des corps jaunes, des corps albicans ou de gros follicules (>7 mm), on a classifié les brebis comme ayant des ovaires actifs ou inactifs. Les brebis étaient classifiées cycliques lorsqu'elles avaient des corps jaunes, albicans ou de gros follicules sur l'ovaire. Elles étaient classifiées non cycliques lorsqu'aucune de ces structures n'était pas rencontrée.

Les résultats indiquent que pour la période d'observation, 42% des brebis du groupe de sélection supérieure avaient une forme d'activité ovarienne caractérisée par la présence de corps jaunes ou de gros follicules comparativement à 24% pour le groupe témoin d'âge similaire, et 31% pour le groupe de sélection inférieure.

La plus grande différence entre les deux groupes de sélection de brebis fut observée dans la période entre le 20 juin et le 25 juillet, la différence de 28 points de pourcentage étant significative ($P < 0{,}10 > 0{,}05$). Très peu de différences furent notées entre le groupe sélectionné et le groupe témoin pour la moyenne des dates d'agnelage des années antérieures. Cependant, d'après les résultats de cette année, une différence marquée aurait dû être notée si une conception pouvait être reliée à la présence de corps jaunes, albicans ou de gros follicules.

Une petite différence fut notée dans le poids des ovaires de brebis classifiées inactives (Stroma ovarien seulement) entre le groupe sélectionné et le groupe témoin, la différence étant significative seulement pour les brebis qui sont nées en 1975. Au cours de ces deux années, les ovaires des brebis sélectionnées étaient légèrement plus lourds que ceux des brebis témoins.

On peut donc conclure, à partir de ces résultats, qu'il y a une grande variation entre les brebis D.L.S. quant à leur capacité à maintenir ou à commencer leurs activités oestrales durant l'été. Conséquemment, afin d'allonger la saison d'accouplement par des saillies durant l'été, on peut utiliser la sélection pour améliorer la population de brebis en ce qui a trait à ce caractère puisque la date d'agnelage a un indice d'héritabilité assez élevé. Cette amélioration s'est manifestée dans cette expérience par la performance relativement meilleure du groupe de brebis sélectionnées comparativement au groupe témoin.

Comparaisons de deux techniques de vérification des chaleurs chez la brebis en fonction de l'ovulation. Pour améliorer l'efficacité de reproduction de leurs troupeaux, les éleveurs d'ovins doivent contrôler les dates de saillies des brebis pour sélectionner celles qui ont un début de saison sexuelle hâtif et un taux de conception élevé. Pour ce faire, l'éleveur a le choix entre deux méthodes: le berger peut prendre note des accouplements lorsque le bélier est envoyé dans le troupeau ou il peut laisser le bélier demeurer avec le troupeau en ayant soin de le munir d'un crayon marqueur;

le berger n'aura alors qu'à relever les marquages. Les deux techniques comportent des inconvénients: la première demande beaucoup de temps et la deuxième est moins précise. C'est ce que nous avons voulu vérifier dans cette étude en évaluant les techniques selon l'ovulation.

Vingt-neuf brebis D.L.S. de troisième parité ont été utilisées pour cette étude. Au 1 mai, soit après une période d'adaptation de 24 jours, on a placé 6 ou 7 brebis par enclos avec un bélier vasectomisé portant un crayon marqueur. Chaque matin, le berger notait le numéro et la date des brebis marquées. Par la suite, on enlevait le bélier marqueur pour vérifier son efficacité par rapport à un bélier boute-en-train. Chaque brebis qui tolérait la monte du nouveau bélier était considérée en chaleur et enlevée de l'enclos pour permettre au boute-en-train de vérifier les autres brebis. Le numéro de la brebis était noté, qu'elle ait été marquée ou non par le bélier marqueur. À la fin des vérifications quotidiennes des chaleurs, le bélier marqueur était retourné dans l'enclos avec ses brebis habituelles. À chaque lundi et jeudi, on prélevait des échantillons sanguins de chaque brebis pour doser la progestérone. On indiquait qu'il y avait ovulation si le taux de progestérone était plus élevé que 0,4 mg/mL plasma et demeurait au-dessus de ce niveau pour au moins trois prélèvements consécutifs.

Avec les béliers marqueurs, qui demeuraient avec les brebis, on a détecté 301 chaleurs, alors qu'avec le boute-en-train, introduit chaque matin dans l'enclos, on en a relevé 261. Dans 88% des cas, il y avait correspondance entre le marquage et la monte. Cependant, le bélier introduit quotidiennement a permis de détecter 32 chaleurs de plus que le bélier marqueur. Par ailleurs, parmi les 301 chaleurs détectées par les béliers marqueurs 73 chaleurs étaient fausses; les marquages ne correspondaient ni à la monte, ni à l'ovulation. Soixante-six pour cent des fausses chaleurs sont survenues surtout durant la période anestrale, juste avant le début des saisons de reproduction, d'où la difficulté, avec cette technique du bélier marqueur, de déceler précisément le début de la saison d'accouplement.

On peut conclure que la technique du bélier boute-en-train introduit chaque matin est beaucoup plus fidèle à l'activité ovarienne de la brebis, surtout au début de la saison sexuelle. Cependant, en pleine saison d'accouplement, les deux techniques sont également bonnes.

Production fourragère et sols

L'application d'azote sur une prairie à prédominance de luzerne. On n'applique ordinairement pas d'engrais azotés sur une prairie où prédomine la luzerne car cette légumineuse, grâce aux bactéries logées dans les nodules de ses racines, fixe l'azote de l'air du sol et pourvoit ainsi à son alimentation azotée. Mais sous notre climat québécois, le froid réduit peut-être l'activité bactérienne des nodules durant les périodes de températures fraîches du printemps et de l'automne. Un apport d'azote suppléerait alors au ralentissement de l'activité des rhizobia et permettrait d'augmenter le rendement de la prairie sans trop y diminuer le pourcentage de légumineuses.

Afin de vérifier cette hypothèse, nous avons entrepris une expérience pour déterminer l'effet des applications d'azote sur une prairie de luzerne et de fléole (mil). En 1977, on a ensemencé de la luzerne Alfa à raison de 9 kg/ha et de la fléole de prés Climax à la dose de 7 kg/ha. On a appliqué de la pierre à chaux aux doses suivantes: 0,6 et 12 t/ha. De l'azote sous forme de nitrate d'ammoniaque a été appliqué aux doses de 0, 25, 50 et 100 kg de N à l'hectare. Ces doses d'azote ont été réparties en deux applications égales: une en fin d'avril et l'autre au début d'août après la deuxième coupe.

Les rendements en matière sèche de l'association luzerne–fléole ont augmenté avec les doses d'azote. Ils ont passé de 7 à 9 t/ha grâce à un apport de 100 kg d'azote à l'hectare. Mais l'action de l'azote a été plus marquée en sol non chaulé. L'augmentation de rendement due à l'azote a été de 60% en sol non chaulé comparativement à 14% en sol chaulé à raison de 12 t/ha. Le chaulage a permis d'abaisser la dose d'azote à 25 kg de N à l'hectare au lieu de 100 kg à l'hectare pour la luzerne cultivée en sol non chaulé. L'application d'azote a produit près de deux tonnes de matière sèche à la troisième coupe. La fumure azotée a réduit le pourcentage de luzerne de l'association luzerne–fléole. Il était en moyenne de 63% dans les parcelles sans azote et il a diminué à 45% à la suite d'une application de 100 kg d'azote à l'hectare. En sol non chaulé, cette réduction a été très accentuée à la dose de 100 kg d'azote à l'hectare. En sol chaulé, le

pourcentage de luzerne a diminué à la dose de 25 kg d'azote à l'hectare et n'a pas beaucoup baissé aux doses plus élevées. Notons en passant, l'action bienfaisante du chaulage sur la luzerne dont le pourcentage s'est sensiblement accru en sol chaulé.

En conclusion, l'application d'azote sur une partie de luzerne–fléole ne devrait pas dépasser la dose de 25 kg à l'hectare. Une plus forte dose risquerait de trop diminuer le pourcentage de luzerne. Un chaulage du sol à pH 6,8 et une application de 25 kg de N à l'hectare permettraient d'obtenir de hauts rendements de foin de luzerne–fléole contenant près de 60% luzerne.

La date de la dernière coupe de luzerne et sa survivance à l'hiver. Un des facteurs de régie qui affecte la productivité d'une luzernière est la date de la dernière coupe. Quand la luzerne est coupée vers la fin de la saison végétale, une repousse réduit les réserves racinaires et la plante n'a pas assez de temps pour les refaire et pour s'endurcir avant les gelées mortelles.

Une expérience entreprise à Lennoxville a bien démontré cet effet. La troisième coupe de luzerne a été faite à chaque semaine sur des parcelles différentes à partir du 25 août jusqu'au 20 octobre. Une parcelle non coupée servait de témoin. Le rendement de la première coupe l'année suivante était plus fort lorsque la dernière coupe avait été effectuée au mois d'octobre au lieu de septembre. On avait alors récolté 6,5 t de luzerne à l'hectare comparativement à 5,5 t pour la coupe faite en septembre. Les racines de luzerne coupées au mois d'octobre étaient plus sèches et avaient une conductivité plus faible (donc elles étaient plus endurcies). En effet, elles contenaient 36% de matière sèche comparativement à 34% pour la luzerne coupée en septembre. Elles avaient une conductivité totale de 13,9 Mho $\times 10^4$ comparativement à 15,5 Mho $\times 10^4$ pour les racines de luzerne dont la partie aérienne avait été coupée en septembre.

Il n'est donc pas à conseiller de couper la luzerne au mois de septembre. On risquerait de l'affaiblir vu son faible degré d'endurcissement.

Influence de la motoneige sur les propriétés de la neige et du sol. La motoneige est devenue en quelques années un sport très populaire. Au Québec, quelque 200 000 motoneiges circulent sur 50 000 km de pistes entretenues et cartographiées par les divers clubs de motoneigistes. Jusqu'à présent on ne s'est guère préoccupé de vraiment connaître les effets de la pression exercée par ce véhicule sur la neige et sur le sol sous-jacent. Sur une période de deux ans, on a recréé le milieu où évolue d'ordinaire la motoneige en y délimitant des pistes à la station de recherche de Lennoxville. Des thermocouples ont été enfouis à tous les 10 cm de profondeur dans le sol sous la piste et à deux mètres en dehors de la piste. L'expérience commencait dès qu'il y avait 10 cm et plus de neige sur le sol. On a effectué 150 passages par semaine en motoneige et cela, tant qu'il y avait de la neige sur le sol. Périodiquement, on mesurait la densité de la neige et la température du sol.

On sait que la couverture de neige, constituée d'un amoncellement poreux de cristaux de glace, possède une valeur isolante très élevée et, normalement, protège le sol contre le gel. La pression exercée par la chenille de la motoneige (0,021 kg/cm^2) fusionne les cristaux et a pour effet une augmentation considérable de la densité de la neige, réduisant par le fait même ses propriétés isolantes. Ainsi, on a mesuré la densité sur trois profils différents de neige fraîche après chaque passage d'une motoneige. On a constaté, qu'après seulement un passage, l'épaisseur de la couverture de neige avait été réduite de moitié et sa densité augmentée de 52%. Il n'a fallu que quatre passages pour que la densité atteigne son niveau maximum. Les températures au niveau du sol sous la neige non tassée ont rarement descendu en bas du point de congélation tandis que, sous la neige tassée, elles ont été beaucoup plus froides et maintenues constamment sous zéro.

Il ne faut pas se surprendre qu'un tel déséquilibre thermal au niveau de la piste ait laissé échapper toute l'énergie calorifique emmagasinée dans le sol et en ait accéléré la pénétration du gel. Au début de l'hiver, à cause d'un manque de neige, le gel s'est introduit dans le sol. En dehors de la piste, à mesure que l'épaisseur de neige augmentait au cours de l'hiver, le front de gel s'est amenuisé graduellement. Par contre, sous la piste, le taux de pénétration du gel (centimètres par semaine) a été quatre fois plus grand et le gel a atteint une profondeur moyenne de 50 cm. Au printemps, le gel sous la piste a persisté en moyenne 17 jours plus longtemps, retardant pas le fait même la fonte de la neige. Les températures des 10 premiers centimètres du sol sous la piste ont atteint le point de congélation dès le début de l'hiver

tandis que, sous la neige non tassée, ce phénomène ne s'est produit que vers la mi-janvier. Les températures entre ces deux traitements se sont équilibrées seulement 29 jours après que la neige fut complètement disparue. Les gels et les dégels ont une grande influence sur le mouvement de l'eau dans le sol puisqu'ils rompent l'équilibre du profil hydrique. À mesure que le front de gel descend sous la piste, il se produit une migration de l'eau vers la portion du sol gelé. Au mois de mars de chaque année, les pourcentages d'humidité du sol gelé ont été de deux à trois fois plus élevés que dans le sol non gelé.

Nos travaux ont prouvé que la montoneige modifiait sensiblement les propriétés de la neige et du sol. La neige tassée laisse pénétrer le froid davantage et les températures du sol sous-jacent deviennent beaucoup plus froides. Le front de gel a pénétré trois fois plus profondément sous la piste. Ces anomalies ont retardé le début de la végétation au printemps, étant donné que la neige prend plus de temps à fondre et que le sol met plus de temps à se réchauffer.

PUBLICATIONS

Recherches

Barnett, G.M.; Comeau, J.E. 1980. Seeding cereals by air ground. Can. J. Plant Sci. 60:1147-1155.

B. de Passillé, A.M.; Hartsock, T.G. 1979. Within- and between-litter variation of proximate composition in newborn and 10-day-old Landrace swine. J. Anim. Sci. 49:1449-1457.

Dionne, J.L.; Roy, G.; Pelletier, G.; Genest, J.; Tremblay, A.; Fernet, C. 1981. Pâturage versus ensilage pour la production laitière. Can. J. Plant Sci. 61:915-927.

Dufour, J.J.; Adelakoun, V.; Matton, P. 1981. Limited multiple ovulation in heifers fed high plane of nutrition before PMSG stimulation and steroid hormone concentrations in single, twin and multiple ovulators. Theriogenology 15:433-441.

Dufour, J.J.; Fahmy, M.H.; Ray, G.L. 1981. The influence of pelvic opening and calf size on calving difficulties of beef × dairy crossbred cows. Can. J. Anim. Sci. 61:279-288.

Fahmy, M.H. 1979. Body and carcass measurements of DLS and Finn sheep × DLS lambs slaughtered at three light body weights. World Rev. Anim. Prod. 15:11-15.

Fahmy, M.H. 1981. Factors influencing the weaning to oestrus interval in swine: A review. World Rev. Anim. Prod. 17:15-28.

Fahmy, M.H.; Friend, D.W. 1981. Factors influencing, and repeatability of the duration of farrowing in Yorkshire sows. Can. J. Anim. Sci. 61:17-22.

Flipot, P.; Pelletier, G. 1980. Influence of methods of conservation on feeding value of high moisture barley fed to dairy steers. Can. J. Anim. Sci. 60:939-943.

Flipot, P.; Pelletier, G.; St-Pierre, J.-C.; Comeau, J.E. 1981. Évaluation de l'ensilage d'herbe entreposé dans des silos-meules et traité avec un mélange formaldéhyde-acide sulfurique (Sylade). Can. J. Anim. Sci. 61:175-180.

Lalande, G.; Dufour, J.J.; Flipot, P. 1981. Performance bouchère et économique des taures de boucherie primipares destinées à l'abattage. Can. J. Anim. Sci. 61:121-129.

Matton, P.; Adelakoun, V.; Couture, Y.; Dufour, J.J. 1981. Growth and replacement of the bovine ovarian follicles during the estrous cycle. J. Anim. Sci. 52:813-820.

Divers

Barnett, G.M.; Comeau, J.E. 1981. Les semis très hâtifs des céréales. Pages 40-42 *dans*: Faits saillants des travaux de la station de recherche de Lennoxville. Direction générale de la recherche, Station de recherche, Agric. Can., Lennoxville, Québec. Bull. techn. 2. 50 pp.

B. de Passillé, A.M. 1981. Le comportement du porcelet, de la naissance à 10 jours d'âge. Pages 34-39 *dans*: Faits saillants des travaux de la station de recherche de Lennoxville. Direction générale de la recherche, Station de recherche, Agric. Can., Lennoxville, Québec. Bull. techn. 2. 50 pp.

Bernard, C.; Fahmy, M.H.; McQueen, R.; Crober, D.C. 1980. Animal germ plasm in North America. Pages 15-38 *dans*: 75th Anniversary Symposia: Agriculture 2000, Macdonald College. 269 pp.

Bouchard, R.; Roy, G.L.; Vinet, C.; St-Laurent, G. 1981. Influence du stade du mil à la fenaison et du niveau de concentrés sur la performance de la vache laitière. Pages 7-13 *dans*: Faits saillants des travaux de la station de recherche de

Lennoxville. Direction générale de la recherche, Station de recherche, Agric. Can., Lennoxville, Québec., Bull. techn. 2. 50 pp.

Carrier, F.; Dionne, J.-L. 1981. L'agriculture face à la pollution des eaux du bassin de la St-François par les éléments azote, phosphore et potassium. Direction générale de la recherche, Station de recherche, agric. Can., Lennoxville, Québec. Bull. techn. 3. 90 pp.

Carrier, F.; Touchette, M.; Dufour, J. 1981. Situation de l'élevage ovin dans les Cantons de l'Est en 1979. Direction générale de la recherche, Station de recherche, Agric. Can., Lennoxville, Québec, Bull. techn. 4. 74 pp.

Dionne, J.L. 1981. Systèmes de fumure pour une rotation de quatre ans. Pages 46-50 *dans*: Faits saillants des travaux de la station de recherche de Lennoxville. Direction générale de la recherche, Station de recherche, Agric. Can., Lennoxville, Québec. Bull. techn. 2. 50 pp.

Dufour, J.J.; Adelakoun, V.; Matton, P. 1981. Probabilité accrue de la gémellité par une ration riche en énergie servie avant une stimulation par la PMSG. Pages 19-23 *dans*: Faits saillants des travaux de la station de recherche de Lennoxville, Agric. Can., Lennoxville, Québec. Bull. techn. 2. 50 pp.

Fahmy, M.H. 1981. La Large White anglaise la meilleure race à bacon? Bull. agric. (janvier):8P-9P.

Fahmy, M.H. 1981. Qu'arriverait-il si on oubliait de soigner ses porcs? Bull. agric. (mai):31P-32P.

Flipot, P.; Dubé, N.; Nadeau, M. 1981. Utilisation de sous-produits dans les rations à bouvillons. Pages 105-127 *dans*: Symposium sur l'engraissement de bouvillons au Québec, 1 avril 1981, C.P.A.Q., M.A.P.A.Q. 127 pp.

Flipot, P.; Roy, G.L.; Dufour, J.J. 1981. Influence du niveau d'énergie de la ration sur la production et la composition du lait de la vache Holstein. Pages 14-18 *dans*: Faits saillants des travaux de la station de recherche de Lennoxville. Direction générale de la recherche, Station de recherche, Agric. Can., Lennoxville, Québec, Bull. techn. 2. 50 pp.

Lachance, B.; Beauchemin, K. 1981. Les veaux de grains, déja une réalité. Bull. agric. (janvier):24 et 26.

Lachance, B.; Beauchemin, K. 1981. Vers des veaux de plus en plus lourds. Bull. agric. (mai):42, 44-45.

Lachance, B.; Beauchemin, K.; St-Laurent, G.; Bouchard, R. 1981. Alimentation du veau lourd d'abattage nourri d'aliments d'allaitement ou de grains. Pages 24-33 *dans*: Faits saillants des travaux de la station de recherche de Lennoxville. Direction générale de la recherche, Station de recherche, Agric. Can., Lennoxville, Québec. Bull. techn. 2. 50 pp.

Lalande, G.; Dionne, J.-L.; Flipot, P. 1981. Le taurillon Holstein peut-il produire une viande de qualité? Bull. agric. (août):86-88, 90.

Martel, Y. 1981. Liste des publications scientifiques, des articles récents de vulgarisation et des projets actuels de recherches. Direction générale de la recherche, Station de recherche, Agric. Can., Lennoxville, Québec. Bull. techn. 1. 19 pp.

Mason, W. 1981. Réensemencement de la luzerne dans les champs endommagés par l'hiver. Pages 43-45 *dans*: Faits saillants des travaux de la station de recherche de Lennoxville. Direction générale de la recherche, Station de recherche, Agric. Can., Lennoxville, Québec. Bull. techn. 2. 50 pp.

Pelletier, G.; Dionne, J.L.; Roy, G. 1981. Que penser des rations complètes pour la vache laitière? Bull. agric. (juillet):66.

Pelletier, G.; Roy, G.; Dionne, J.L.; Genest, J. 1981. Comparaison de divers systèmes fourragers pour la production du lait. Pages 3-6 *dans*: Faits saillants des travaux de la station de recherche de Lennoxville. Direction générale de la recherche, Station de recherche, Agric. Can., Lennoxville, Québec. Bull. techn. 2. 50 pp.

Pelletier, G.; Roy, G.; Dionne, J.L.; Genest, J. 1981. Le meilleur système fourrager pour la production du lait. Bull. agric. (février):58-59.

Pesant, A. 1981. La luzerne aurait bien hiverné. Bull. agric. (avril):20 et 22.

Station de recherche
Sainte-Foy, Québec

CADRES PROFESSIONNELS

Administration

S.J. Bourget, B.Sc. (Agr.), M.S., Ph.D.	Directeur
C. Gagnon, B.A., B.Sc. (Agr.), M.Sc., Ph.D.	Directeur adjoint
R. Labelle	Services administratifs

Soutien scientifique

P. Venne,[1] B. Bibl., M.L.S.	Bibliothèque

Amélioration des plantes

J.M. Deschênes, B.Sc. (Agr.), M.Sc., Ph.D.	Chef de la section; écologie
M. Bernier-Cardou, B.Sc., M.Sc.	Statistiques
M.R. Bullen, B.Sc. (Agr.), M.Sc., Ph.D.	Génétique des plantes fourragères
J.P. Dubuc, B.Sc. (Agr.), Ph.D.	Génétique des céréales
M. Germain, B.Sc. (Agr.), M.Sc.	Physiologie des graminées fourragères
P. Goulet, B.Sc.	Informatique
A. Légère, B.Sc., M.Sc.	Malherbologie
R. Michaud, B.Sc. (Agr.), M.Sc., Ph.D.	Génétique des légumineuses
J. Surprenant, B.Sc. (Agr.), M.Sc.	Génétique des graminées fourragères

Physiologie des plantes

R. Paquin, B.A., B.Sc. (Agr.), M.Sc., Ph.D.	Chef de la section; survie à l'hiver
R. Bolduc, B.A., B.Sc. (Agr.), Ph.D.	Résistance au froid, cytologie
Y. Castonguay, B.Sc. (Agr.), M.Sc.	Agrométéorologie
H.J. Hope, B.Sc., M.Sc., Ph.D.	Résistance au froid, mécanisme
C. Willemot, B.S.A., M.Sc., Ph.D.	Résistance au froid, mécanisme

Phytoprotection

C. GAGNON, B.A., B.Sc. (Agr.), M.Sc., Ph.D.	Chef de la section; maladies des légumineuses
L. BORDELEAU, B.Sc. (Agr.), M.Sc., Ph.D.	Microbiologie
A. COMEAU, B.Sc., Ph.D.	Entomologie
L. COUTURE, B.A., B.Sc. (Agr.), M.Sc., Ph.D.	Maladies des céréales
R. LALONDE, B.Sc. (Agr.), M.Sc., Ph.D.	Microbiologie
C. RICHARD, B.Sc., M.Sc., D.Sc.	Maladies des légumineuses
J. SANTERRE, B.A., B.Sc., M.Sc.	Nématologie
P. SAVOIE, B.Sc. (Agr.), M.Sc., Ph.D.	Génie des plantes fourragères

Sols

C. DE KIMPE, B.A., Ing. Chim. et Ind. agr., D.Sc.	Chef de la section; génèse
D. ISFAN, B.Sc., Ph.D.	Chimie et fertilité
M. LAVERDIÈRE, B.Sc. (Agr.), M.Sc., Ph.D.	Pédogénèse et minéralogie
J. ZIZKA, B.A., B.Sc. (Agr.), M.Sc.	Fertilité

Ferme expérimentale, La Pocatière

J.E. COMEAU, B.Sc. (Agr.), M.Sc.	Régisseur
L. BELZILE, B.Sc. (Agr.), M.Sc.	Plantes fourragères
A. FRÈVE, B.Sc. (Agr.), M.Sc.	Pommes de terre
R. RIOUX, B.A., B.Sc. (Agr.), M.Sc.	Herbicides et malherbologie

Ferme expérimentale, Normandin

POSTE VACANT	Régisseur; bovins laitiers et céréales
R. DRAPEAU, B.Sc. (Agr.), M.Sc.	Plantes fourragères

Départs

J.P.F. DARISSE, B.A., B.Sc. Promu régisseur de la ferme expérimentale de L'Assomption	Régisseur, Normandin
J.C. ST-PIERRE, B.Sc. (Agr.), M.Sc., Ph.D. Promu analyste des programmes à Ottawa	Physiologie des plantes fourragères

CHERCHEURS INVITÉS

H. ANTOUN, B.Sc. (Agr.), M.Sc., Ph.D.	Écologie du Rhizobium
T. MCLOUGHLIN, B.Sc. (Agr.), Ph.D. Boursier de l'O.C.D.E.	Microbiologie

ÉTUDIANTS

Étudiants à la maîtrise

A. BOUCHARD (patron, J.M. Deschênes)	Biologie des mauvaises herbes
Y. DION (patron, A. Comeau)	Amélioration et pathologie végétale
S. GAGNÉ (patron, C. Richard)	Phytopathologie
B. KABORE (patron, L. Couture)	Pathologie des céréales
S. LABERGE (patron, L. Bordeleau)	Biochimie
C. LAFRENIÈRE (patron, L. Bordeleau)	Microbiologie
G. LALIBERTÉ (patron, R. Paquin)	Phytotechnie
B. LANDRY (patron, A. Comeau)	Biochimie
A.M. LAPOINTE (patron, J.M. Deschênes)	Biologie, compétition et seuil de nuisibilité du chénopode blanc
C. LEMIEUX (patron, J.M. Deschênes)	Écologie des mauvaises herbes
F.M. OUANOUKI (patron, J. Santerre)	Nématologie
Y. POLYNICE (patron, J.M. Deschênes)	Écologie des jachères
H. ROUSSEAU (patron, C. Richard)	Phytopathologie
R. SAUVAGEAU (patron, L. Bordeleau)	Microbiologie

Étudiant au doctorat

L. VÉZINA (patron, R. Paquin)	Phytotechnie

[1]Détaché de la Direction générale des affaires financières et administratives, Division des bibliothèques.

INTRODUCTION

Les travaux amorcés à Sainte-Foy et aux fermes expérimentales de La Pocatière et de Normandin ont été poursuivis afin d'atteindre les objectifs fixés. On a lancé un nouveau programme sur les mycorhizes. On a engagé de nouveaux chercheurs en agrométéorologie, en microbiologie, en génie et en physiologie des plantes fourragères.

En plus des publications scientifiques, et de la participation des chercheurs au transfert de technologies, il faut souligner l'homologation d'une variété d'avoine et d'une variété de luzerne.

Pour obtenir de plus amples renseignements, veuillez vous adresser à: Station de recherche, Agriculture Canada, 2560 boulevard Hochelaga, Sainte-Foy, Québec G1V 2J3.

S.J. Bourget
Directeur

LES PLANTES

La survivance à l'hiver

Influence du climat. Des six espèces vivaces cultivées en champ en 1980–1981, la fléole des prés (mil, cultivar Engmo) fut la plus résistante au gel, la TL_{50} (température pour 50% de mortalité) atteignant –32°C et moins. Elle fut suivie par le seigle (cultivar Cougar) et le brome (cultivar Saratoga) avec des TL_{50} de –28 à –30°C, puis du blé (cultivar Kharkov) et du triticale (cultivar Wintri) avec –26 à –29°C. La luzerne (cultivar Rambler) fut la moins résistante avec une TL_{50} de –23,2°C seulement. Des six espèces, la fléole des prés fut celle qui a conservé sa résistance au gel le plus longtemps au printemps 81, celle-ci étant de –16,6°C le 4 mai, comparativement à –9,3°C pour la luzerne. Faudrait-il voir là la raison pour laquelle le mil résiste mieux que les autres espèces sous nos conditions hivernales? Les résultats des prochaines années devraient nous fournir la réponse.

L'irrigation a eu peu d'effet sur la survie et la résistance au gel de la luzerne au cours de l'automne 80. À cause du peu de neige et de la fonte hâtive (dégel du sol en mars), la mortalité hivernale fut plus forte, s'élevant de 10 à 18% chez le témoin et les parcelles drainées. Comme pour les années précédentes, la formation de glace en automne a été cause de mortalité et la présence subséquente de la neige fut inefficace. Par contre, la formation de glace en février n'a pas causé de dommages.

Physiologie de la résistance. L'endurcissement à +1°C des racines du blé et de la luzerne permet de prolonger de beaucoup leur survie suite à l'emprisonnement dans la glace.

Le refroidissement des racines de luzerne est essentiel à l'acquisition de la résistance au gel et à l'accumulation de la proline, indépendamment de la température maintenue au niveau de la partie aérienne. Le refroidissement d'une section du bas de la tige à 1°C interfère avec la translocation de la proline: celle-ci diminue dans tous les organes de la plante à 1°C, mais pas à 5°C. Il y aurait donc un seuil entre 1 et 5°C au-dessus duquel la translocation ne serait pas gênée.

La teneur maximale en proline des collets de six espèces (luzerne, brome, mil, blé d'hiver, triticale et seigle) cultivées en champ a coïncidé avec le maximum de résistance au gel de chacune, entre janvier et mars, et a varié de 45 à 60 micromoles par gramme de matière sèche (μmol/g M.S.). Au printemps, la teneur en proline a diminué rapidement chez les espèces à l'exception du mil dont la teneur atteignait 24,4 μmol/g M.S. le 4 mai. Quant aux sucres totaux, la teneur maximale des collets chez les six espèces a varié de 346 à 378 mg/g M.S., donc sensiblement la même. La teneur en sucres réducteurs des mêmes organes a montré une plus grande variation, soit de 8 mg/g M.S. pour la luzerne à 141 pour le seigle.

Biochimie de la résistance. Suite à une congélation létale à –10°C, on observe une dégradation rapide des lipides membranaires, soit environ un tiers des phospholipides après 6 h de dégel à 20°C et deux tiers après 24 h et une diminution rapide de leurs acides gras polyinsaturés. Les triglycérides (lipides de réserves) continuent cependant de s'accumuler pendant au moins 6 h. La destruction des tissus par la gelée semble donc impliquer au

début la destruction rapide des lipides membranaires, peut-être suite à une perte de compartimentalisation cellulaire.

L'acétate-^{14}C est rapidement incorporé dans les lipides des bouts de racines du blé d'hiver, mais beaucoup plus dans les stérols que dans les acides gras. Le ^{14}C-oléate, absorbé sous forme de sel d'ammonium, est incorporé dans la phosphatidylcholine pour y être ensuite dessaturé en linoléate. L'oléate et le linoléate sont finalement incorporés dans les triglycérides.

L'étude des protéines à l'aide de l'électrophorèse sur gel d'acrylamide a montré que l'incorporation de la leucine, marquée dans deux protéines en particulier, est plus rapide pendant l'endurcissement au froid du blé d'hiver et diminue durant le désendurcissement. L'une des deux protéines s'est révélée, chez la plante endurcie, résistante à l'autolyse par des protéases isolées des mêmes tissus, indiquant par là un «turnover» très bas.

L'étude a révélé également que l'autolyse des protéines est plus rapide à des pH de 3 à 4 et de 6 à 8 qu'à tout autre pH entre 2 et 9. Des expériences avec la leucine tritiée ont montré qu'une période de 6 à 8 h est nécessaire à la plante pour commencer à s'adapter à des changements brusques de température à 3 et à 15°C.

La phosphatase acide libérée sous l'action du gel possède une structure amphipatique qui caractérise les protéines membranaires. La purification à l'aide de la lipase a révélé que l'enzyme, une glycoprotéine avec une teneur en sucres de 30%, est associé avec les lipides membranaires.

Les plantes fourragères

Fixation d'azote. En biotechnologie, nous avons tenté de trouver de nouvelles connaissances qui permettent une économie d'énergie d'environ 70$ par hectare de légumineuses cultivées par la mise en valeur de la fixation d'azote. Nous avons démontré que l'efficacité symbiotique du *Rhizobium meliloti* est affectée par la présence de nitrate dans le milieu mais qu'une compatibilité des activités nitrate réductase et nitrogénase du système symbiotique avec la luzerne est possible. Nous avons mis au point une méthode isotopique pour évaluer l'effet du nitrate sur la colonisation des racines de luzerne par le *R. meliloti*. On a aussi démontré qu'un haut taux d'introduction au champ du *R. meliloti* avec la luzerne, de l'ordre de 10^6 cellules de *Rhizobium* par graine, donne un établissement maximum de la plante et des rendements en matière sèche supérieurs aux fertilisants azotés sous les meilleures conditions de croissance. L'étude de la fixation symbiotique d'azote dans l'Arctique nous a révélé que des systèmes biologiques fonctionnent à des températures voisines du point de congélation; les *Rhizobium* qui nodulent ces plantes offrent des caractéristiques de croissance et d'adaptation intéressantes pour l'ingénierie génétique en ce qui a trait à l'amélioration du système symbiotique de nos plantes tempérées comme la luzerne.

Luzerne. La production de semence du sélectionneur du nouveau cultivar de luzerne APICA a été assez abondante pour permettre la production, par l'intermédiaire du SeCan, de semence généalogique en vue de la commercialisation. Ce nouveau cultivar s'est bien comporté dans les essais de cultivars dans l'est du pays. Un second cultivar expérimental, le Mn Syn-2, a subi avec succès plusieurs essais comparatifs; l'évaluation sera poursuivie. Trois autres populations expérimentales ont été multipliées et elles feront partie des essais en 1982.

Un essai d'introduction de luzerne a été exploité pour une troisième année. Deux populations en provenance de Russie se sont classées immédiatement après les cultivars témoins. On a encore constaté que les cultivars développés dans l'Ouest sont incapables de s'adapter à nos conditions.

Les 200 plants de luzerne recueillis dans des champs très endommagés au cours de l'hiver 1979–1980 ont été entrecroisés et leurs lignées descendantes seront évaluées de 1982 à 1984.

Concernant la résistance aux maladies, l'accent a surtout été mis sur les maladies de racines. Ainsi, deux cycles de sélection pour la résistance à la flétrissure fusarienne ont été complétés chez quatre populations. On a fait une évaluation comparative de ces populations en laboratoire. Les populations issues de deux cycles de sélection ont montré de 30 à 50% plus de résistance (moins de maladie) que les populations originales.

Deux cycles de sélection ont également été complétés pour la résistance au pourridié fusarien chez quatre cultivars. L'évaluation de ces populations en laboratoire est en cours.

Une expérience en parcelles a été implantée (1981) à St-Augustin et à Normandin en vue d'évaluer au champ les effets des deux cycles de sélection pour la flétrissure fusarienne et le

pourridié fusarien sur le rendement et l'incidence de la pourriture de racines. Un essai réalisé au champ et complété en 1980 a révélé une très forte corrélation ($r = -0,90$) entre la pourriture des racines de la luzerne et le rendement. Cette information confirme la relation étroite entre le froid, le développement de la pourriture et la persistance qui affecte le rendement.

Une nouvelle sélection a porté sur la résistance combinée au froid et au *Fusarium*. Les plants sélectionnés ont été entrecroisés et la population issue de cette sélection sera évaluée.

On a trouvé une interaction significative entre le *Rhizobium meliloti* et le *C. insidiosum* (flétrissure bactérienne). Les clones susceptibles à la flétrissure bactérienne ont mieux répondu à l'inoculation avec le *R. meliloti* que les clones résistants ce qui suppose une meilleure réceptivité de la plante-hôte à l'infection par le *R. meliloti* lorsque celle-ci est susceptible à la flétrissure bactérienne.

Suite aux expériences avec les *Fusarium* et la résistance au froid, l'effet de la mineuse virgule sur le conditionnement au froid de la luzerne a été expérimenté. Nous avons pu constater que l'action de la mineuse avait un effet négatif sur la résistance au gel. Des pertes de rendement allant jusqu'à 75% ainsi qu'une réduction de la dimension des feuilles, de la hauteur des plantes et du nombre de tiges par plante ont été observées chez les plantes minées.

Trèfle rouge. Les résultats du test de descendance des 86 plantes sélectionnées ont donné les résultats suivants: 6 lignées hautement supérieures, 22 très supérieures et 36 supérieures au témoin. Un deuxième cycle de sélection est en cours chez la descendance des 36 meilleures plantes qui, d'autre part, a été introduite en parcelles d'évaluation avec 7 autres cultivars.

Fléole des prés. On a poursuivi les travaux de sélection de la fléole en vue d'accroître sa teneur en protéines brutes et sa digestibilité. Une pépinière de descendance issue de 49 plantes sélectionnées pour les caractères susmentionnés a été exploitée en 1981. Les lignées descendantes les plus faibles au point de vue rendement ont été rejetées.

Les essais sur la production de semence de fléole indiquent qu'un taux de semis de 3,0 kg/ha est suffisant. L'action de la plante-abri lors de l'implantation s'est révélée bénéfique à La Pocatière, mais elle a été nuisible à Kapuskasing. Les semis de printemps ont donné de meilleurs rendements que les semis effectués en août. Une plus grande fertilisation d'azote a produit des épis plus longs.

Dactyle. Treize clones de dactyle ont été sélectionnés sur la base d'essais de descendance au champ et d'essais de descendance effectués en chambre de congélation. Ces clones serviront de base à un cultivar expérimental.

Mélanges fourragers. L'hiver 1980–1981 n'a pas été favorable aux légumineuses contribuant ainsi à une diminution importante du trèfle rouge et de la luzerne. Cette diminution s'est traduite par une augmentation des mauvaises herbes surtout le pissenlit. Les parcelles semées en 1978 ont été les plus touchées. Les rendements de 1981 ont été inférieurs à ceux de 1980 surtout à cause de la diminution des légumineuses, la compensation partielle par les graminées et l'augmentation des mauvaises herbes. La substitution des espèces n'est que partielle et nous n'entrevoyons pas qu'elle puisse jamais devenir complète. Des examens et des analyses plus poussés seront effectués.

Quant à l'évaluation des herbicides destinés à enrayer les mauvaises herbes dans les mélanges fourragers, les résultats montrent qu'à l'exception du 2,4-DB et de certains mélanges à base de 2,4-DB, aucun produit n'a semblé prometteur. La phytotoxicité des produits envers la graminée ou la légumineuse a été très élevée, surtout en serre.

Mauvaises herbes. À l'hiver 1981, on a repris en serre les travaux visant à déterminer le seuil de nuisibilité du chénopode blanc dans la luzerne. Les résultats laissent supposer que la présence du chénopode affecte surtout la production de tiges et par conséquent le rendement en poids sec par unité de surface. Le rendement en poids sec par tige de luzerne demeure à peu près le même, peu importe la densité de la population du chénopode. Une augmentation de la densité des mauvaises herbes (de 400 à 1600 tiges au mètre carré) n'accentue pas les pertes de façon proportionnelle: à D-400, les effets du chénopode sur la luzerne sont déjà très marqués.

Les expériences qui portent sur la nuisibilité d'une association d'espèces (ortie–tabouret) dans la luzerne ont été mises en marche en serre à l'hiver 1981 et au champ à l'été 1981. Il reste à compiler les études. À l'hiver 1981,

on a commencé les travaux visant à déterminer la période critique d'interférence du chénopode blanc dans la luzerne. Les résultats—très préliminaires—suggèrent que les effets de compétition du chénopode sur la luzerne se font sentir dès la 2e semaine à densité élevée de mauvaises herbes (1600 tiges au mètre carré). À faible densité (400 tiges au mètre carré), les effets tarderaient légèrement à se manifester: les pertes ne seraient significatives qu'à partir de la 4e semaine. Si le chénopode est toléré plus longtemps, les pertes augmentent de façon proportionnelle.

L'inventaire des mauvaises herbes s'est poursuivi dans les régions de la Mauricie, de la Beauce et, dans les comtés de Bellechasse et de Montmagny.

Les céréales

Amélioration. L'avoine Shaw, spécialement adaptée aux provinces maritimes, a été homologuée par la station de Sainte-Foy qui est responsable de l'amélioration de l'avoine dans ces provinces. Cette avoine a la paille la plus forte, la meilleure adaptation à ces provinces et un rendement de 3,4% supérieur au plus haut des 10 témoins utilisés, ce qui représente une plus value de 1 000 000$ par année pour l'ensemble des producteurs des Maritimes.

Grâce à ses travaux d'évaluation du blé, la station de Sainte-Foy a pu collaborer à l'homologation du cultivar Mondor par Agriculture Québec. Ce blé possède un avantage de 3% en rendement sur le Casavant dans la région de Montréal.

La diversification des efforts d'Agriculture Canada dans le financement de la recherche a permis l'octroi d'un contrat de recherche de 60 000$ à une compagnie privée, en 1981, pour intensifier l'évaluation de l'orge. Ce contrat de 180 000$ est renouvelable pour deux autres années.

Pathologie. Les enquêtes ont démontré que le OA421.7 et le Fidler avaient la meilleure résistance à la rouille couronnée tandis que le Lamar était le moins susceptible à la septoriose et à la jaunisse nanisante (V.J.N.O.). Un catalogue de références a été fait sur les avoines résistantes à la septoriose et sur la situation de l'anthracnose des céréales au Québec.

Dans la lutte chimique contre les maladies, quatre nouveaux produits s'avèrent intéressants: le CGA-64250 donne la meilleure répression de la septoriose, le CGA-64251, la meilleure répression de la brûlure du semis, le EL-228 contrôle mieux les charbons nus et le PP333 diminue la tache septorienne. On a, de plus, prouvé que la hauteur des plants va à l'inverse de l'infection au *Fusarium* spp. chez les trois céréales de printemps.

Il semble que quatre espèces d'avoine, le *stérilis*, le *macrostachya*, l'*occidentalis* et le *strigosa* possèdent de hauts niveaux de résistance à la jaunisse nanisante (V.J.N.O.) mais seuls les gènes du *stérilis* sont hautement héritables. Dans la tribu des Triticeae, les genres *Agropyron* et *Secale* possèdent des niveaux de résistance appréciables.

Malherbologie. Les inventaires des mauvaises herbes dans les champs de céréales se sont poursuivis en Mauricie, Beauce, Bellechasse et Montmagny. Jusqu'ici, l'ampleur des problèmes démontre l'importance des pratiques culturales pour les enrayer.

Chez le chénopode, le seuil de nuisibilité a été déterminé et les pertes chez la céréale augmentent jusqu'à 800 tiges de chénopode au mètre carré. De plus, la période critique de nuisibilité se situe au-delà de 3 semaines de croissance de la céréale, car le chénopode affecte le tallage et le poids sec de la plantule chez la céréale.

Les études biologiques démontrent que l'ortie et le chénopode ont une faible mortalité et une grande plasticité phénologique. Par contre, ces deux espèces varient énormément dans l'utilisation des ressources, car chez l'ortie, il n'y a que peu d'hiérarchisation tandis que chez le chénopode, il y a une très grande hiérarchisation i.e. que peu d'individus dominants s'accaparent la majeure partie des ressources.

LES SOLS

La fertilité

Matière organique et azote. Une étude sur 11 sols du Québec et quatre doses d'azote sous forme de ^{15}N (N_0, N_1, N_2, N_3) a été réalisée en serre en vue de déterminer la capacité des sols à fournir de l'azote minéral aux plantes. La teneur en matière organique des sols variait de 2,96 à 9,67%, le pH de 5,0 à 7,3 et la teneur en argile de 9,0 à 86,9%. On a effectué trois récoltes d'avoine. Les rendements ont varié de 3,5 à 16,7 g de matière sèche par pot et ils sont fortement liés à l'interaction matière organique × doses d'engrais azoté, interaction qui explique 81% de la variation des rendements. L'azote exporté (azote contenu

dans la partie aérienne des plantes) a varié de 61 à 701 mg de N par pot et il est relié plus à l'azote ajouté (R^2 = 0,93) qu'à la matière organique. L'azote exporté dérivé de l'engrais (% N.d.f.f.) a augmenté avec l'accroissement des doses d'azote bien que, en même temps, le pourcentage de l'utilisation de l'engrais azoté a diminué de façon significative. La quantité d'azote exporté qui provient du sol a diminué de façon significative avec l'augmentation des doses d'engrais. Ces résultats expliquent pourquoi le «priming effect» a été aussi peu évident. Les valeurs «A» ont augmenté de façon significative avec les doses d'azote pour certains sols (100, 138 et 187 à N_1, N_2 et N_3, respectivement) tandis que pour d'autres sols, ces valeurs sont restées à peu près constantes.

Fertilisation des céréales. On a réalisé une expérience en serre pour déterminer la réponse de sept variétés d'avoine à des doses croissantes d'engrais azoté. Les résultats indiquent que la réponse des variétés à la fertilisation azotée est fort différente tant au point de vue des rendements que de la teneur en protéines. On a obtenu le rendement le plus élevé pour la variété Cascade (=100%), puis Scott (=91%) et Lamar (=88%) tandis qu'à l'autre bout, on retrouvait les variétés Elgin (=53%) et Manic (=76%). Les variétés Cascade, Lamar et Scott ont bien réagi, même à de fortes doses d'engrais, tandis que les variétés Manic et Laurent ont accusé des diminutions de rendement pour ces mêmes doses élevées. Le gain maximum de rendement attribué à la fertilisation a été plus élevé pour les variétés Cascade et Scott que pour les variétés Manic et Elgin. Pour les variétés à haut rendement (Cascade et Scott), le rendement des épis principaux a toujours été plus élevé que celui des épis secondaires. Pour les variétés les moins productives (Manic et Elgin), le rendement des épis principaux a très peu augmenté avec des doses croissantes d'azote et le gain de rendement attribué à l'engrais a été obtenu surtout par les épis des talles. La contribution moyenne des grains des épis principaux au rendement total a été de 70 et 67% pour les variétés Cascade et Scott et de seulement 43 et 46% pour les variétés Manic et Elgin. Il y a donc une relation positive entre le rendement des épis principaux et le rendement total des grains. Le pourcentage moyen de protéines dans les graines est plus élevé chez les variétés Manic et surtout Elgin. Dans tous les cas, il est aussi plus élevé dans les graines des épis principaux.

Fertilisation de la luzerne. Une expérience de champ est toujours en cours pour évaluer l'effet de trois doses de P, K et S sur les rendements de la luzerne. On a effectué deux coupes cette année et les rendements moyens ont varié de 1857 kg/ha à 2985 kg/ha à chaque coupe.

La pédogénèse

Mise en culture des sols. On a effectué une deuxième récolte sur les horizons purs et en mélange des séries Laurentide et Leeds. Les sols qui avaient été fertilisés et chaulés ont donné de meilleurs rendements à la deuxième récolte qu'à la première. Cependant, quand le traitement se limitait au chaulage seulement, le rendement paraissait influencé par la texture des mélanges et leur contenu en matière organique. Ainsi, les mélanges préparés à partir des divers horizons du sol Laurentide (texture grossière) ont donné des rendements moins élevés à la deuxième récolte, alors que les mélanges préparés à partir du sol Leeds (texture plus fine) ont donné de meilleurs rendements à la deuxième récolte au moins pour les mélanges à contenus élevés en matière organique. Il est possible que ce sol s'épuise moins vite que le sol Laurentide et que les éléments nutritifs soient moins rapidement lessivés. Ceci serait confirmé par le fait que des mélanges de sol Leeds ayant reçu seulement des engrais ont donné de meilleurs rendements à la deuxième récolte qu'à la première, mais seulement pour les mélanges qui impliquent les horizons LH et Ae, alors que les rendements étaient de faibles à nuls pour les mélanges impliquant l'horizon B.

Fixation du phosphore et C.E.C. Un horizon B podzolique de la série Calder a été incubé à la capacité au champ pendant un an en présence de quantités variables de P allant de 0 à 1500 mg/kg. Les courbes de titration potentiométrique en présence de solutions de NaCl de concentration variable ont démontré un abaissement marqué du point de charge zéro (P.Z.C.) pour des quantités croissantes de P. Ainsi, le P.Z.C. passait d'un pH de 4,30 pour le témoin à 3,35 avec une addition de P à 1500 mg/kg. Au point de titration zéro, la charge passait de 0,25 à 8,2 meq/100 g. Des mesures d'absorption de Na^+ et Cl^- sur ces sols incubés montrent que la C.E.C. à pH 6,0 passe de 1,45 meq/100 g pour le témoin à 3,6 meq/100 g après addition de P à 1500 mg/kg.

Propriétés physiques du sol. Les propriétés de rétention d'eau par la matière organique

du sol et, dans une moindre mesure, par la fraction argileuse, ont une influence directe sur le comportement des sols lors du tassement; on observe que la densité apparente sèche des sols décroît pour des teneurs croissantes en matière organique et en argile. Les valeurs de conductivité hydraulique des sols compactés est inférieure à 1 cm/h parce que le pétrissage requis pour obtenir la densité maximum a rompu la continuité du système poreux. Dans le cas des échantillons tassés, la conductivité hydraulique saturée varie de 0,8 à 234 cm/h. Pour les échantillons tassés, les valeurs de conductivité hydraulique sont fonction de la teneur en argile et du contenu en agrégats stables.

Propriétés chimiques des sols. Les matériaux amorphes ou facilement extraits ont été mis en solution par divers réactifs dans deux podzols du Québec. Les résultats globaux ont indiqué que le mélange dithionite–citrate–bicarbonate extrait le maximum de ces produits à condition de diminuer le rapport solide/solution par rapport aux valeurs généralement recommandées. Il faut en effet tenir compte du faible degré de solubilité de la silice.

Pour un des profils, prélevé dans les Appalaches, l'extraction des matériaux amorphes a permis une meilleure interprétation des spectres de diffraction des rayons-X, alors que pour le second profil, échantillonné dans les Laurentides, la même extraction était indispensable pour obtenir un spectre de diffraction montrant quelques pics. Lors de ces extractions, des pertes de poids qui atteignaient jusqu'à 70% du poids de l'échantillon ont été enregistrées et elles étaient attribuées non seulement aux oxydes de fer, d'aluminium et de silicium, mais aussi à l'eau d'hydratation des formes amorphes. Aucun produit de néoformation, comme l'imogolite, n'a pu être mis en évidence dans l'horizon B podzolique inférieur. Il n'est cependant pas impossible que ces produits existent un peu plus bas dans le profil.

Dans les conditions expérimentales du laboratoire, nous avons en effet pu démontrer qu'il n'était pas indispensable que le matériel en réaction ait la composition du produit final pour qu'il y ait cristallisation. Une séparation de phases est possible et le processus de cristallisation paraît plus influencé par les conditions de pH et la présence de cations.

FERME EXPÉRIMENTALE LA POCATIÈRE

Les céréales

Biologie et écologie des mauvaises herbes. Un inventaire des mauvaises herbes présentes dans les cultures céréalières a été réalisé dans la région du Bas St-Laurent et de la Gaspésie. Cent soixante-neuf champs ont été visités. Le chiendent, le chénopode blanc, la renouée liseron, l'ortie royale, la spargoute, la vesce jargeau et la stellaire moyenne sont les mauvaises herbes qu'on a relevées le plus souvent. La fréquence de l'ortie royale et de la spargoute est plus élevée en Gaspésie que dans le Bas St-Laurent.

Régie. Dans une monoculture d'orge, l'emploi continu des herbicides phonoxys et du bromoxynil a déplacé les feuilles larges au profit des graminées annuelles et du chiendent. Sur un loam sableux St-André, la sétaire glauque et le pied-de-coq sont devenus les espèces dominantes après quatre ans d'utilisation de l'un ou l'autre des produits. Sur l'argile Kamouraska, après 3 ans, le chiendent est devenu l'espèce dominante.

Les plantes fourragères

Chiendent. Les BAS-9052 employés aux taux de 0,4 à 0,6 kg/ha ont donné une excellente répression du chiendent dans la luzerne, l'année du semis. L'année suivant le semis, seul le TF 1169 au taux de 1,5 kg/ha avait encore une répression importante (75%). Le pourcentage de protéines et la digestibilité des fourrages de luzerne qui contiennent du chiendent sont associés de façon négative et linéaire au contenu en chiendent.

Semence de luzerne enrobée avec un herbicide. L'E.p.t.c. enrobé avec la semence de luzerne a affecté la vigueur des plantules en serre. En champ, les plantules et le rendement ont été affectés seulement lorsqu'il y avait 69 g d'E.p.t.c. par kilogramme de semence. L'efficacité contre les mauvaises herbes de l'herbicide enrobé avec la semence a été influencée par le pH du sol.

Régie du semis. L'établissement de la luzerne, du lotier, du brome et du mil n'a pas été amélioré par l'utilisation de semences enrobées en sol bien préparé et bien cultivé. Avec le brome et le mil, aucun des trois types d'enrobage étudiés n'a montré d'effet positif. Les semis directs de luzerne, de trèfle rouge et de lotier ont bien fait ressortir l'importance de

la précision technique pour réaliser de bons établissements par cette méthode d'implantation. Les conditions qui prévalent au moment du semis et lors de l'établissement des plantules semblent aussi et même encore plus importantes que les types de sol sur lesquels ont lieu les semis. Des trois légumineuses ensemencées (lotier, luzerne, trèfle rouge), c'est le trèfle rouge qui semble encore le plus facile à implanter par cette méthode de semis. L'utilisation en semis direct de semence enrobée n'a pas semblé favoriser un meilleur établissement. Aussi la présence d'E.p.t.c. dans l'enrobage de la semence de luzerne n'a pas eu d'effet tangible dans la lutte contre la végétation adventice.

Besoins en azote. Sans aucun apport d'azote le rendement du mil a été beaucoup plus faible sur le loam graveleux St-André que sur l'argile Kamouraska. La luzerne n'a guère répondu aux applications d'azote. Le mode de semis en rang a été supérieur à celui à la volée sur les deux types de sol étudiés. Sur le loam graveleux St-André le semis en rang du mélange mil–luzerne a été le meilleur mode de semis et, sur l'argile Kamouraska, c'est le mode deux rangs alternés de mil et de luzerne. Le mil associé en rangs alternés avec la luzerne a semblé profiter de la présence de la légumineuse. Cet effet était plus marqué sur le loam graveleux St-André que l'argile Kamouraska.

Production de semence du trèfle rouge. Malgré quelques dommages au cours de l'hiver 1980–1981, les populations de trèfle rouge sont demeurées suffisantes pour permettre l'application des traitements de régie et de prélever une récolte de semence. La coupe de la partie végétative à 100 et 75% en fleurs a retardé considérablement la maturation de la repousse de telle sorte qu'en début de septembre la plupart des plants étaient encore végétatifs et en fleurs. Pour espérer obtenir sous nos conditions une production convenable de semence de trèfle rouge, le prélèvement de la partie végétative doit être fait à un stade hâtif.

Les pommes de terre

Irrigation. Sur une moyenne de 3 ans, l'irrigation a augmenté le rendement des pommes de terre de 16,88 t/ha sur un sable loameux St-Pacôme et 14,1 t/ha sur un loam sableux St-André. Sur le sable loameux St-Pacôme, l'irrigation permet d'augmenter les rendements de 60%. De plus, l'irrigation permet aussi d'augmenter l'efficacité de la fertilisation azotée. Sur le loam sableux St-André, l'augmentation moyenne du rendement, grâce à l'irrigation et à l'application d'azote à 90 kg/ha, était de 15,8 t/ha. Grâce à l'irrigation, on peut s'attendre à une augmentation du rendement de l'ordre de 43% dans ce cas.

Étude sur les maladies et pucerons de Kamouraska à Trois-Pistoles. L'étude a eu lieu pendant l'été 1980. Les pucerons les plus importants sont, dans l'ordre décroissant: le Macrosyphym, l'Aphys, le Myzus et l'Aulacortum. Les envols semblent avoir eu lieu entre le 14 juillet et le 4 août. Le nombre de pucerons diffère d'une région à l'autre. Les classes de semences sont distinctes lors des tests sérologiques et des autres maladies. Dans tous les cas, les producteurs pour la consommation ont plus de problèmes phytosanitaires que ceux qui font de la semence.

Sélection des lignées. En 1981, 630 nouvelles lignées provenant de Frédéricton (N.B.) et sélectionnées au stade quatre buttes ont été plantées sur deux sols. D'après les résultats de rendements, croustille et cuisson à l'eau, comparés aux témoins Norland, Superior et Kennebec, 34 lignées ont été conservées. Des lignées sélectionnées en 1979, il en reste une seule à soumettre à l'essai d'adaptation (E.A.). Des 36 lignées sélectionnées en 1980, une dizaine devront être soumises à l'essai avancé d'adaptation (E.A.A.) et une quinzaine à l'E.A. à La Pocatière. Parmi celles qui sont déjà en cours d'essais, il y en a huit qui semblent prometteuses. Les essais hâtifs, avancés d'adaptation F, avancés d'adaptation U.S.A. et inter-régional effectués en collaboration avec les stations provinciales ont permis de tester respectivement 19, 18, 25 et 11 lignées différentes.

Inoculation: flétrissement bactérien et jambe noire. Il semble que la jambe noire, lorsqu'elle est inoculée en forte concentration masque le flétrissement bactérien. De plus, la variété Superior cause certains problèmes lors du diagnostic sur le feuillage car la variété mûrit rapidement sous nos conditions.

Les arbres fruitiers

Pommes et prunes. Le temps doux de février 1981 a causé la mort de certains pruniers parmi les mieux protégés du vent (17%) comme le Verity, l'Early, l'Italien, le Vision et le 0531. Des Melba et des Golden Delicieuse

ont également été très affectés par cet hiver (gel des bourgeons). La qualité des fruits a été de bonne à mauvaise (rousselure, fruits difformes, tavelure d'automne). Les rendements ont été très variables selon les variétés, mais dans l'ensemble c'est plus faible qu'en 1980 pour les pommiers et les poiriers. Par contre, les pruniers plantés en 1975 comme le Reine-Claude, le Bradshaw bleu et le V33028 ont respectivement produit 22,9, 21,9 et 13,2 kg, et parmi ceux plantés en 1977, certains ont produit pour la première année: par exemple, le Victoria (0,75 kg) et le V33028 (0,41 kg).

FERME EXPÉRIMENTALE NORMANDIN

Systèmes de plafond poreux pour étable

La température et l'humidité relative ont été enregistrées dans une étable à logettes qui était pourvue d'un plafond poreux fait d'un matériau isolant en fibre de verre sans coupe-vapeur et supporté par un treillis métallique. Au cours de l'étude, l'épaisseur du plafond poreux a été de 63 et 126 mm formant un rapport plafond/plancher de 0,3 et 0,6, respectivement. La température de l'air mesurée en amont de ventilateurs en opération constante a été représentative du gradient thermique dans l'étable. On a jugé que le rapport plafond/plancher obtenu de l'isolation de 126 mm d'épaisseur a été plus efficace que les autres conditions étudiées pour obtenir une température plus élevée dans l'étable quand la température extérieure était basse. En effet, à une température extérieure de −40°C, celle de l'étable a varié de −1°C à −10°C selon ces systèmes utilisés. Il n'a pas été possible d'établir des corrélations définies entre l'humidité relative et les températures intérieures et extérieures. Cependant, on a identifié une faible corrélation entre les valeurs d'humidité relative mesurées simultanément en amont de deux ventilateurs en opération constante.

Les plantes fourragères

Étude de mélanges à foin. On a étudié l'évolution et la qualité de la fléole des prés et du brome cultivés seuls et en association avec la luzerne ou le trèfle rouge. Le rendement annuel moyen en matière sèche des graminées seules, fertilisées à l'azote, a été supérieur à celui de leur association aux légumineuses. La contribution la mieux équilibrée des espèces au rendement a été obtenue du mélange de l'une ou l'autre graminée avec le trèfle rouge. Le mélange graminée-luzerne a livré le plus haut rendement en protéines à l'hectare, alors que les graminées seules avec une fumure azotée de 72 à 90 kg/ha avaient la plus faible teneur en protéines. La densité de la fléole et du brome associés aux légumineuses a augmenté au cours des deux premières années de récolte; la troisième annee, elle s'est accrue avec la fléole, mais s'est stabilisée et a même diminué avec le brome. Du point de vue qualité, l'association graminée–luzerne est la plus recommandable, suivie de l'association graminée–trèfle rouge et enfin, les graminées en monoculture.

Régie de coupe de la luzerne. Sous les conditions de la région du Lac St-Jean, la meilleure production d'un fourrage de qualité est obtenue quand la première fauche est effectuée entre le 20 juin et le 7 juillet (stade bouton à 75% floraison), et la deuxième entre le 10 et le 25 août (seconde floraison). Quand les quantités de fourrage récolté sont suffisantes pour la saison hivernale, il n'y a pas avantage à faire une troisième récolte en octobre car elle est généralement faible. De plus, la pousse d'arrière saison contribue à retenir la neige et ainsi à protéger la luzerne contre le froid avec exposition au vent.

Les céréales

Blé de printemps. L'essai coopératif Québec–Maritimes comportait trois sélections locales pour étudier leur comportement en vue d'homologation possible d'au moins un cultivar. De plus, 17 autres sélections locales ont été vérifiées dans cinq essais de tamisage répartis dans le nord de l'Ontario, au Québec et dans les Maritimes. Environ 4200 épis individuels ont été sélectionnés dans du matériel en disjonction (F2 à F6) pour des critères de précocité et de rendement élevé.

PUBLICATIONS

Recherches

Bolduc, R.; Zvereva, G.N.; Trunova, T.I. 1981. Effets de la résistance au gel du blé d'hiver sur les phosphatases acides non spécifiques. Fiziol. Rast. 28:601-606 [en russe].

Bordeleau, L.M.; Giroux, M.; Ouellette, R.; Antoun, H. 1981. Effet du soufre et de l'azote sur la fixation symbiotique d'azote chez les plantules de luzerne (*Medicago sativa* L.). Can. J. Plant Sci. 61(3):634-645.

Bordeleau, L.M.; Michaud, R. 1981. Association between resistance to bacterial wilt and symbiotic nitrogen fixation in alfalfa. Phytoprotection 62:39-43.

De Kimpe, C.R.; Kodama, H.; Rivard, R. 1981. Hydrothermal formation of kaolinite-like product from amorphous aluminosilicates. Clays Clay Miner. 29:446-450.

De Kimpe, C.R.; Laverdière, M.R.; Zizka, J. 1981. Effet du modelage des champs sur l'hétérogénéité des sols et les rendements en maïs-grain. Can. J. Soil Sci. 61:225-236.

Deschênes, J.M.; Dubuc, J.P. 1981. Effets de l'humidité du sol, des dates de semis et des mauvaises herbes sur le rendement des céréales. Can. J. Plant Sci. 61:851-857.

Drapeau, R.; Darisse, F. 1981. Influence d'un paillis de polyéthylène sur la production de concombre en région nordique. Can. J. Plant Sci. 61(3):683-690.

Federoff, N.; De Kimpe, C.R.; Page, F.; Bourbeau, G.A. 1981. Essais d'interprétation des transferts sous forme figurée dans les podzols du Québec méridional à partir de l'étude micromorphologique des profils. Geoderma 26:25-45.

Isfan, D. 1981. Forecasting corn nitrogen fertilizer rate based on soil water fluctuation, *dans* Communications in soil science and plant analysis. Vol 12 (11).

Laverdière, M.R.; De Kimpe, C.R.; D'Avignon, A. 1981. Caractéristiques minéralogiques et chimiques de quelques sols sableux du Québec en regard de leur évolution pédologique. Can. J. Soil Sci. 61:273-283.

Légère, A.; Payette, S. 1981. Ecology of a black spruce (*Picea mariana* (Mill.) BSP) clonal population in the hemiarctic zone, Northern Québec: population dynamics and spatial development. Arct. Alp. Res. 13(3):261-276.

Munroe, J.A.; Wolynetz, M.S.; Turnbull, J.E.; Darisse, J.P.F. 1981. Cold weather conditions in a free stall barn fitted with a porous ceiling. Can. J. Agric. Eng. 23(1):17-81.

Paquin, R.; Pelletier, G. 1981. Acclimatation naturelle de la luzerne (*Medicago media* Pers.) au froid. 1. Variations de la teneur en proline libre des feuilles et des collets. Physiol. Veg. 19(1):103-117.

Richard, C. 1981. Examen de la microflore endoracinaire de la luzerne en fonction de l'âge, de l'état sanitaire et de l'emplacement dans la racine. Phytoprotection 62:67-68.

Richard, C.; Michaud, R.; Frève, A.; Gagnon, C. 1980. Selection for root and crown rot resistance in alfalfa. Crop Sci. 20:691-695.

Rioux, R.; Gosselin, J.; Généreux, H. 1981. Effets des dates de plantation sur les pommes de terre cultivées en saisons courtes. Can. J. Plant Sci. 61:417-424.

St-Pierre, C.A.; Dubuc, J.P.; Klinck, H.R.; Pelletier, G. 1981. L'orge de printemps Sophie. Can. J. Plant Sci. 61:153-156.

Williams, R.J.; Hope, H.J. 1981. The relationship between cell injury and osmotic volume reduction: III. Freezing injury and frost resistance in winter wheat. Cryobiology 18:133-145.

Williams, R.J.; Willemot, C.; Hope, H.J. 1981. The relationship between cell injury and osmotic volume reduction: IV. The behavior of hardy wheat membrane lipids in monolayer. Cryobiology 18:146-154.

Divers

Antoun, H.; Bordeleau, L.M. 1981. Yield of alfalfa (*Medicago sativa* L.) inoculated with different strains of *Rhizobium meliloti* in the presence of nitrate-N. N. Am. Rhizobium Conf. (8th) Proc. 5 pp.

Belzile, L. 1980. Évaluation des cultivars de dactyle pour le Québec. Bull. techn. du Conseil des productions végétales du Québec. 17 pp.

Belzile, L. 1981. Compte rendu du voyage d'étude du Comité des herbages du C.P.V.Q. dans la province de Québec (région(s) Bull. techn. du Conseil des productions végétales du Québec. 19 pp.

Belzile, L. 1981. Enrobage des semences des plantes fourragères. Bull. techn. du Conseil des productions végétales du Québec. 59 pp.

Belzile, L. 1981. Winter survival on alfalfa (1979-80) at La Pocatière, *dans* Survey report on the winter survival on alfalfa (1979-80) *par* C.E. Ouellet, Misc. Bull. 19, janvier 1981. Section agrométéorolique, Institut de recherche sur les terres, Direction générale de la recherche, Agriculture Canada, Ottawa, Ont.

Bolduc, R. 1981. Acid Pase: An intrinsic membrane protein used as a method to monitor freezing damages in plants. Plant Physiol. 14:30.

Bolduc, R. en collaboration. 1980. La culture du blé d'hiver en voie d'être rendue possible dans tout le Canada. Herbages: Culture. Conseil des productions végétales du Québec. Agriculture Québec. Agdex 120/20: 37 pp.

Coulombe, L.J.; Granger, R.L.; Frève, A.; Généreux, H. 1981. Observations sur la rouille du cognassier chez le pommier à La Pocatière, Québec. Can. Plant Dis. Surv. 61(2):25-28.

Couture, L. 1981. Mélanges céréaliers et maladies. Agriculture 37(4):28.

Couture, L.; Sutton, J.C. 1980. Effect of dry heat treatments on survival of seed borne Bipolaris sorokiniana and germination of barley seeds. Can. Plant Dis. Surv. 60(4):59-61.

Dubuc, J.P. 1981. L'implication des compagnies privées en recherches phytogénétiques. Une possibilité! Agriculture 38:25-27.

Frève, A. 1981. Essai régional hâtif 1980, La Pocatière. Rapport annuel 1980 des essais régionaux de pommes de terre au Québec. Comité de la pomme de terre; amélioration des variétés. Éditeur G.J. Banville, Les Buissons, Saguenay, (MAPAQ). pp. 25-28.

Hope, H.J.; Langlois, J.R. 1981. Use of endogenous proteases to identify changes in protein metabolism in winter wheat during cold hardening. Proc. 13th Int. Bot. Congr. p. 260.

McLoughlin, T.; Bordeleau, L.M.; Dunican, L.K. 1981. Ecological studies with marked strains of *Rhizobium trifolii* in two Irish soils. N. Am. Rhizobium Conf. (8th) Proc. 3 pp.

Paquin, R. 1980. Influence de l'environnement sur l'acclimatation et la résistance au gel de la luzerne. Phytoprotection 61:117-118.

Paquin, R. 1981. Cold acclimatation of alfalfa: variations of the total sugar and free proline content of leaves and crowns. Plant Physiol. 67(4):113.

Rioux, R. 1981. Influence du temps de la répression du chiendent avec le glyphosate sur la productivité de l'orge. Can. Agric. 26:20.

Vezina, L.; Paquin, R. 1981. Effect of low temperature on proline translocation and frost hardening of alfalfa. Plant Physiol. 67(4):62.

Station de recherche
Saint-Jean-sur-Richelieu, Québec

CADRES PROFESSIONNELS

Administration

C.B. Aubé, B.Sc. (Agr.), M.Sc., Ph.D.	Directeur
R. Crête, L.S.A., M.Sc.	Directeur adjoint
A. Conti, Doctorat d'État	Chimiste
Y. Bonneau	Services administratifs

Soutien scientifique

I. Wallace,[1] B.A., M.L.S.	Bibliothèque

Fruits

R.O. Paradis, B.A., B.Sc. (Agr.), M.Sc., Ph.D.	Chef de section; entomologie
N.J. Bostanian, B.Sc., M.Sc., Ph.D.	Acarologie–entomologie
L.J. Coulombe, B.A., B.Sc. (Agr.), M.Sc., Ph.D.	Phytopathologie
R.L. Granger, B.Sc., B.S.A., M.Sc., Ph.D.	Physiologie
M.J. Lareau, B.Sc. (Agr.), M.Sc.	Gestion des cultures
I. Rivard, B.A., B.Sc. (Agr.), M.Sc.	Écologie et contrôle de la faune entomologique
G.L. Rousselle, B.A., B.Sc. (Agr.), M.Sc., Ph.D.	Génétique

Légumes

P. Martel, B.A., B.Sc., Ph.D.	Chef de section; toxicologie
G. Bélair, B.Sc.	Nématologie
D. Benoît, B.Sc., M.Sc.	Malherbologie
L. Bérard, B.Sc., M.Sc., Ph.D.	Physiologie de la sénescence
R. Bernier, B.A., B.Sc. (Agr.)	Gestion des cultures
G. Boivin, B.Sc., M.Sc., Ph.D.	Entomologie
M.S. Chiang, B.Sc. (Agr.), M.Sc., Ph.D.	Génétique
M. Hudon, L.Sc. (Agr.), M.Sc. (Ent.)	Entomologie

B. VIGIER, B.Sc. (Agr.)	Gestion des cultures

Génie et sols

A. BÉLANGER, B.Sc., Ph.D.	Chef de section; chimie des pesticides
R. CHAGNON, B.Sc. (Agr.Eng.)	Énergie
J. MILLETTE, B.Sc. (Agr.Eng.), M.Sc.	Hydrologie
L. PARENT, B.S.A., M.Sc.	Physique des sols
R. THÉRIAULT, B.Sc., Doc.Ing.	Mécanisation

Ferme expérimentale, L'Assomption

F. DARISSE, B.Sc., M.Sc.	Surintendant
N. ARNOLD, B.Sc. (Agr.), M.Sc.	Physiologie
M. CARON, B.Sc., M.Sc.	Phytopathologie
M. DUPRÉ, B.A., B.S.A.	Protection
M. LAMARRE, B.Sc. (Agr.)	Phytotechnie
I.S. OGILVIE, B.Sc. (Agr.), M.Sc., Ph.D.	Génétique
C. RICHER-LECLERC, B.Sc.	Gestion des cultures horticoles

Départs

J.A. CAMPBELL, B.A., B.Ed., M.Sc., Ph.D. Muté à Alberta Environment, Edmonton, Alb.	Chimie des sols
P.P. LUKOSEVICIUS, Diplomlandwirt, M.Sc., Ph.D. Muté à la Direction générale de la recherche, Ottawa, au poste d'analyste de programmes	Surintendant

GOUVERNEMENT DE LA PROVINCE DE QUÉBEC

Protection des vergers

M. MAILLOUX, B.S.A., M.Sc.	Entomologie

[1]Détaché de la Direction générale des affaires financières et administratives, Division des bibliothèques.

INTRODUCTION

La station de recherche de Saint-Jean-sur-Richelieu s'occupe des problèmes reliés aux plantes horticoles et ornementales, au tabac, aux sols organiques, aux fines herbes, aux plantes aromatiques et médicinales. L'année 1981 a marqué une étape importante dans l'orientation de la station; premièrement, on a décidé de commencer à L'Assomption un programme de recherche sur la gestion et la protection des plantes ornementales, surtout les arbustes.

De plus, la station de Saint-Jean s'est dotée d'un programme de recherche sur la transformation, en mettant l'accent sur la mise au point de nouveaux produits à partir de plantes médicinales ou condimentaires. Aussi, l'on travaillera à implanter, sur une base économique, des fines herbes destinées aux importateurs canadiens.

Cette année, le Conseil du Trésor a approuvé la préparation des plans et devis du nouveau laboratoire-bureau dont les travaux de construction devraient commencer à l'été de 1982.

Pour de plus amples renseignements sur nos réalisations, pour des tirés-à-part de nos publications, vous pouvez communiquer avec la station de recherche, Direction générale de la recherche, Agriculture Canada, Saint-Jean-sur-Richelieu, Casier postal 457, Province de Québec J3B 6Z8.

Claude B. Aubé
Directeur

TABAC

Production

Production de plantules. Des graines enrobées de tabac à cigarette ont été semées en cellules de Todds dans un dispositif factoriel 4 × 4 × 2 comportant quatre substrats de culture et quatre programmes de fertilisation en serre chauffée et en serre froide. Par rapport à un semis ordinaire en serre, aucune différence significative n'a été notée entre les paramètres étudiés, soit le poids des racines, le poids des feuilles et le rapport racines/feuilles. La culture des plantules en cellules de Todds a permis d'obtenir des plants plus uniformes et une meilleure reprise à la transplantation que les plantules cultivées en sol de serre.

Physiologie

Tabac gris. Défini comme une anomalie physiologique, le tabac gris contribue à la diminution du rendement et de la qualité de la culture. Pour en connaître les causes probables, des plants de tabac à cigarette ont été cultivés, en chambre de croissance, dans un sol qui avait produit du tabac gris et qui a été soumis à cinq niveaux de Fe-EDTA et cinq niveaux de Mn. L'indice moyen de la maladie a semblé être relié à la teneur en Fe dans la feuille. Le Mn a été absorbé de la même façon que le Fe et il pourrait aussi être un agent causal de ce désordre physiologique.

Les symptômes du tabac gris ont été beaucoup plus marqués à pH 4 qu'à pH 6 dans le substrat à base de Fe.

En serre, les plants ont été cultivés en milieux hydroponiques dont l'un contenait cinq niveaux de Fe, et l'autre cinq niveaux de Mn. Les deux éléments ont provoqué l'apparition de la maladie, mais de façon plus marquée avec le Fe; le rôle du Mn reste à déterminer.

Dans des pots dont le sol avait déjà été affecté par le tabac gris, on a incorporé trois taux: un de N.P.K., un de chaux et un de fumier en factoriel. Compte-tenu du poids total du tabac classifié à la récolte, l'incidence du tabac gris a été réduite de 98 à 0% par les amendements combinés de chaux et de fumier. Les taux de N.P.K. n'ont pas eu d'effet mesurable sur la manifestation des symptômes. Sur trois sites différents de culture, le taux relatif de croissance et le bilan net d'assimilation ont été plus élevés sur tabac sain que sur tabac gris.

On a comparé la composition en macro et oligo-éléments d'échantillons de feuilles du tabac jaune (*Nicotianum tobacum* L. 'Delhi 76') et de sols produisant des plants normaux et atteints de l'accident du tabac gris. Les échantillons ont été prélevés de 15 endroits différents au Québec. Les analyses chimiques (moyenne de 15 endroits) révèlent des teneurs très inférieures en N, P, K, Ca et B, mais supérieures en Fe et Al dans les feuilles de

tabac gris. Les sols responsables de l'accident montrent beaucoup moins de N, Ca, matière organique et capacité d'échange cationique, mais plus les feuilles des plants de tabac gris du Québec mûrissent, plus la maladie ressemble très étroitement à des symptômes de toxicité du Fe. Les analyses des composantes principales révèlent que les profils de composition minérale des échantillons de feuilles de tabac normal et atteint sont nettement distinguables, contrairement aux profils correspondants des échantillons de sols.

ARBRES FRUITIERS

Conditions climatiques et mortalité des pommiers

Au Québec, des gelées hâtives survenues les 28 et 29 septembre 1980, des froids intensifs variant de −30 à −36°C enregistrés à la fin de décembre 1980 et au début de janvier 1981, ainsi qu'une période de dégel s'échelonnant du 16 au 24 février suivie de basses températures ont occasionné un fort taux de mortalité des pommiers qui a été évalué à 19% pour les arbres standard et à 9% pour les arbres nains et semi-nains. Chez les pommiers standard adultes, les cultivars Lobo et Melba ont été nettement plus résistants au froid que les cultivars McIntosh et Cortland. Dans un ordre décroissant de rusticité ou de résistance au froid, les lignées de McIntosh sous observation se sont classées comme suit: Mor Spur, MacSpur, Imperial, Starkspur et Starkspur Ultramac; par ailleurs, une classification similaire des lignées du Red Delicious s'établit ainsi: Carnefox, Redspur, Starkrimson, Hardispur et Wellspur.

Mycorhizes et croissance des pommiers

Au moment de leur plantation en serre, des pommiers des clones M 111 et M 7 ont été inoculés avec une lignée des mycorhizes du frêne, *Glomus epigaeus*. Cultivés dans un milieu stérile de montmorillonite, les arbres traités et les arbres témoins ont été alimentés avec la solution nutritive «Long Ashton» et ils ont reçu au besoin de l'eau distillée. Quinze semaines après l'inoculation, la taille des pommiers du clone M 7 était 1,6 fois supérieure à celle des pommiers témoins. De même, la surface des feuilles et leur poids en matière sèche étaient, respectivement, 1,8 et 1,9 fois plus élevés chez les arbres M 7 traités que chez les M 7 non traités. Toutefois, avec le clone M 111, on n'a décelé aucune différence significative entre les arbres traités et non traités. L'examen microscopique a révélé toutefois la présence de nombreuses colonies de *G. epigaeus* chez les deux clones. Sur chaque porte-greffe, les mycorhizes ont augmenté considérablement la teneur en phosphore et en cuivre des feuilles. Elles auraient cependant diminué l'absorption du potassium chez le M 7.

Protection des pommiers

Insectes. Dans un verger expérimental à Frelighsburg (Québec), on a décelé la présence de cinq espèces de miridés phytophages: la punaise terne, *Lygus lineolaris* (P. de B.), la punaise de la pomme, *Lygocoris communis* (Knight), la lygide du pommier, *Lygidea mendax* Reuter, la punaise de la molène, *Campylomma verbasci* (Meyer), et la punaise de l'aubépine, *Heterocordylus malinus* Reuter. Dès le mois d'avril, les adultes hibernants de la punaise terne piquent les bourgeons des pommiers, y provoquant ainsi des exsudations, puis le dessèchement de ces bourgeons. Cette espèce, toutefois, cause peu de dommages aux pommes puisque, après la période de floraison, elle délaisse le pommier pour se développer sur les plantes de couverture croissant dans le verger ou sur le pourtour. La punaise de la pomme, la lygide du pommier et la punaise de l'aubépine passent l'hiver à l'état d'oeufs qui éclosent au cours de la période de floraison des pommiers McIntosh. Dans des sections de verger non traitées, les larves des deux premières espèces ont occasionné de sérieux dégâts aux pommes, tandis que la punaise de l'aubépine a toujours été présente en densité négligeable. Les oeufs d'hibernation de la punaise de la molène ont éclos lorsque les fleurs de pommiers étaient au stade du calice et une deuxième génération a commencé en juillet. Les spécimens de cette espèce ont été abondants, mais n'ont pas causé de dégâts aux pommes du cultivar McIntosh.

À l'aide de pièges englués faits d'un carton blanc (15 cm × 20 cm) ne réfléchissant pas les radiations ultraviolettes et suspendus aux branches de pommiers à 0,75 m du sol, il a été possible de procéder au dépistage de toutes ces espèces de punaises en verger, à l'exception, toutefois, de la punaise de la molène. Pour cette espèce, les pièges doivent être suspendus à 1,5 m du sol.

PETITS FRUITS

Bleuetiers géants

Les cultivars de bleuetiers géants Bluetta, Earliblue, Bluecrop, Blueray, Berkeley, Jersey, Burlington et Coville, à l'essai à la ferme expérimentale de Frelighsburg (Québec), ont survécu aux mauvaises conditions climatiques décrites plus haut sous la rubrique des arbres fruitiers, mais ils n'ont pratiquement pas fleuri et n'ont pas porté fruits en 1981. Ces cultivars, plantés en 1972, avaient rapporté de 6,5 à 12,8 kg de bleuets en 1980.

Fraisiers

Les essais de lutte contre l'anthonome du fraisier, *Anthonomus signatus* Say, et la punaise terne, *Lygus lineolaris* (P. de B.), qui infestent les fraisiers, ont comporté deux pulvérisations d'insecticides, l'une effectuée le 21 mai au début de la période de floraison du cultivar Redcoat et l'autre, une dizaine de jours plus tard, soit le 1er juin. Les pyréthrinoides de synthèse, comme le perméthrine, le fenvalerate, le cyperméthrine et le décaméthrine de même qu'un organophosphoré, l'azinphos-méthyl se sont tous avérés efficaces contre la punaise terne. Contre l'anthonome, les meilleurs résultats ont été obtenus avec le perméthrine, le fenvalerate et l'azinphos-méthyl. Enfin, les rendements en poids ont été nettement plus élevés dans les parcelles traitées au fenvalerate que dans celles traitées à l'azinphos-méthyl et au décaméthrine.

Framboisiers

Parmi un groupe de 13 cultivars de framboisiers à l'essai, ceux qui, en 1981, ont fourni les meilleurs rendements (kilogrammes par hectare) s'établissent comme suit: Gatineau 5500, Twiddell 5000, Comet 4400, Boyne 4350 et Killarny 4300.

LÉGUMES

Production des légumes

On a démontré que la fermeté des oignons durant l'entreposage varie de 36 à 80% selon les cultivars et la perte totale causée par la pourriture et la germination varie de 3 à 63%.

Les cultivars de chou qui maintiennent la meilleure qualité après cinq mois en entrepôt réfrigéré ne sont pas ceux qui donnent le meilleur rendement au champ.

Les essais de culture du topinambour ont démontré que les sols organiques ne sont pas propices à cette culture, favorisant une pousse accrue des parties aériennes au détriment des tubercules.

Gestion des sols organiques

Après 4 ans d'observations, nos recherches ont démontré qu'à la ferme expérimentale de Sainte-Clotilde, nous avons pu réduire de moitié le rythme de l'affaissement des sols organiques à l'aide d'un programme de conservation de sol, comprenant des brise-vent et une culture de couverture. Dans les champs qui n'étaient pas protégés contre l'érosion, le rythme de l'affaissement avait plus que doublé.

Protection des légumes

On a identifié 17 populations de *Plasmodiophora brassicae* Wor., dont une nouvelle qui infecte également le groupe *Brassica napus* L. et le *B. oleracea* L.; elle vient de l'Alberta et a été identifiée comme suit: 16/03/31, soit la race 7.

Par des infestations artificielles en cages, on a déterminé que ce sont surtout les jeunes stades de la punaise terne qui causent le coeur noir du céleri.

On a identifié deux nouveaux foyers de résistance du doryphore de la pomme de terre au Furadan et à certains organophosphorés dans les régions de Saint-Michel et de Cookshire.

Les nématicides granulés réduisent la migration, l'éclosion et l'activité du nématode cécidogène dans le sol, mais seulement pour une courte durée qui suffit pour assurer une bonne protection à la racine de carottes.

Les cultivars de carottes Spartan Premium, Spartan Classic et plusieurs hybrides qui proviennent du Michigan State University ont démontré une tolérance à l'attaque du nématode cécidogène. Le cultivar Gold Pak demeure le cultivar de carotte le plus sensible au nématode.

PUBLICATIONS

Recherches

Arnold, N.; Chong, C.; Binns, M. 1981. A comparative study of the mineral nutrients in grey and non grey flue-cured tobacco. Can. J. Plant Sci. 61:703-710.

Boivin, G.; Mailloux, G.; Paradis, R.O.; Pilon, J.G. 1981. La punaise terne, *Lygus lineolaris* (P. de B.) (Hemiptera: Miridae), dans le sud-ouest du Québec. 1- Information additionnelle sur son comportement dans les fraisières et framboisières. Ann. Soc. Entomol. Québec. 26:131-141.

Boivin, G.; Mailloux, G.; Paradis, R.O.; Pilon, J.G. 1981. La punaise terne, *Lygus lineolaris* (P. de B.) (Hemiptera: Miridae), dans le sud-ouest du Québec. 2- Biologie et mouvement des populations sur certaines mauvaises herbes. Ann. Soc. Entomol. Québec. 26:159-169.

Bostanian, N.J. 1981. The St-Jean Mite Cage. Can. Entomol. 113:359-360.

Bostanian, N.J.; Paradis, R.O.; Pitre, D. 1981. Susceptibility of phytophagous mites to a single summer treatment of acaricides in a Quebec apple orchard. Phytoprotection 62(1):33-38.

Bostanian, N.J.; Paradis, R.O.; Pitre, D. 1981. Essais de traitements préventifs en verger contre le tétranyque rouge du pommier, *Panonychus ulmi* (Koch) et l'ériophyide du pommier, *Aculus schlechtendali* (Nalepa). Phytoprotection 62(1):53-58.

Bouchard, D.; Tourneur, J.C.; Paradis, R.O. 1981. Bio-écologie d'*Aphidoletes aphidimyza* (Rondani) (Diptera: Cecidomyiidae) prédateur du puceron du pommier, *Aphis pomi* De Geer (Homoptera: Aphididae). Ann. Soc. Entomol. Québec. 26(2):119-130.

Brach, E.J.; Crête, R. 1981. Rapid method of estimating numbers of spores of *Plasmodiophora brassicae* in inoculum suspension. Can. J. Plant Pathol. 3(2):106-109.

Chiang, M.S. 1981. Problems encountered in breeding for resistance to *Plasmodiophora brassicae* through interspecific hybridization. Proc. Eucarpia "Cruciferae 1981":8.1-8.2.

Chiang, M.S.; Chiang, B.Y.; Grant, W.F.; Crête, R. 1981. Transfer of resistance to race 2 of *Plasmodiophora brassicae* from *Brassica napus* to common cabbage. Symposium international sur le chou de Siam. pp. 415-421.

Chiang, M.S.; Crête, R. 1981. Quantitative studies on inheritance of resistance to race 2 of *Plasmodiophora brassicae* in rutabaga. Proc. Eucarpia "Crucifera 1981":5.1-5.4.

Chong, C.; Chiang, M.S.; Crête, R. 1981. Thiocyanate ion content in relation to clubroot disease severity in cabbage. HortScience 16:663-664.

Coulombe, L.J.; Granger, R.L.; Frève, A.; Généreux, H. 1981. Observations sur la rouille du cognassier à La Pocatière, Québec. Can. Plant Dis. Surv. 61(2):25-28.

Coulombe, L.J.; Jacob, A. 1981. Épidémiologie et répression de la tavelure du pommier, *Venturia inaequalis*, de 1972 à 1979, à Frelighsburg, Québec. Phytoprotection 62(1):44-52.

Granger, R.L. 1981. Tree fruit physiology trials underway at the C.D.A. Farm of Frelighsburg, Québec. Fruit Notes 46(4):12-14.

Granger, R.L. 1981. Notes concerning the harsh winter of 1980–81. Fruit Notes 46(4):14-16.

Greenhalgh, R.; Bélanger, A. 1981. Persistence of carbofuran in a Humic mesisol and the effect of degradation and storing on residue level in soil sample. J. Agric. Food Chem. 29:231-235.

Lareau, M.J.; Rousselle, G.L. 1981. Red color evaluation of McIntosh apples with the 'Techwest' color meter. Can. J. Plant Sci. 61:757-759.

LeBlanc, J.P.R.; Hill, S.B.; Paradis, R.O. 1981. Essais de piégeage du charançon de la prune, *Conotrachelus nenuphar* (Hbst.) (Coléoptères: Curculionidae), dans une pommeraie du sud-ouest du Québec. Ann. Soc. Entomol. Québec. 26:182-190.

MacPhee, A.; Paradis, R.O. 1981. Integrated pest management in apple orchards in Eastern Canada. Japan Natl. Inst. Agric. Sci. Proc. 1:67-76.

McLeod, D.G.R.; Dupré, M. 1981. Laboratory rearing and biology of the white cutworm *Euxoa scandens* (Riley). Ann. Soc. Entomol. Québec. 26:95-99.

Millette, J.A.; Vigier, B.; Hogue, E.J. 1981. Seedbed preparation for carrot production on organic soil. J. Am. Soc. Hort. Sci. 106(4):491-493.

Paradis, R.O.; Rivard, I.; Mailloux, M. 1981. Les ravageurs des cultures fruitières au Québec en 1980. Ann. Soc. Entomol. Québec. 26(2):142-145.

Vrain, T.C.; Fournier, Y.; Crête, R. 1981. Carrot yield increases after chemical control of root-knot nematode in organic soil. Can. J. Plant Sci. 61:677-682.

Divers

Arnold, N.; Binns, M.; Barthakur, N. 1981. Effects of air ions on the growth and chemical composition of tobacco plants. Biometeorology 8, part 1. Travaux du neuvième congrès international, Osnabruck et Stuttgart, Hohenheim, du 23 septembre au 1 octobre, 1981.

Boivin, G.; Vincent, C. 1981. La lutte intégrée contre les arthropodes ravageurs. Partie II—Techniques modernes: dépistage et utilisation d'un modèle. Agriculture 38(2):12-14.

Campbell, J.A.; Millette, J.A. 1981. Subsidence of organic soil in Eastern Canada. Station de recherche, St-Jean-sur-Richelieu, Québec. Bull. techn. 13. 26 pp.

Campbell, J.A.; Millette, J.A.; Rayment, F.; Frascarelli, L. 1981. Oxygen limits crop growth in organic soils. Can. Agric. 1981:21-24.

Chamberland, E.; Vigier, B. 1981. Le resserrement des rangs comme moyen de hausser le rendement des légumes à gousses. Agriculture 38(1):8-9.

Coulombe, L.J.; Granger, R.L.; Frève, A.; Généreux, H. 1981. Observations sur la rouille du cognassier à La Pocatière, Québec. Can. Plant Dis. Surv. 61(2):25-28.

Crête, R.; Tartier, R.; Devaux, A. 1981. Les maladies de l'oignon au Canada/Diseases of onions in Canada. Agric. Can. Publ. 1716. 37 pp.

Crevier, D.; Jutras, P.J.; Lawand, T.J.; Thériault, R. 1981. Le potentiel d'application des bassins solaires au Canada en matière d'agriculture. Compte rendu du congrès national sur l'énergie solaire (SESCI). pp. 310-313.

Granger, R.L. 1981. Conduite des vergers à fortes densités au Québec/Management of high-density orchards in Québec. Station de recherche, Saint-Jean-sur-Richelieu, Québec. Bull. techn. 17.

Granger, R.L. 1981. Conduite des vergers à fortes densités. Agriculture 38(2):7-11.

Granger, R.L. 1981. Paul-Omer Roy agronome-pomologiste, promoteur de l'industrie de la pomme au Québec de 1926 à 1967. Agriculture 37(4):26-27.

Granger, R.L.; Rousselle, G.L. 1981. Porte-greffes, systèmes de formation et cultivars de pommiers à fortes densités au Québec. Station de recherche, Saint-Jean-sur-Richelieu, Québec. Bull. techn. 7 (révisé).

Hudon, M. 1981. Une étude internationale de 12 ans de la pyrale du maïs. Agriculture 37:23-24, 27.

Jasmin, J.J.; Hamilton, H.A.; Millette, J.; Hogue, E.J.; Bernier, R.; Campbell, J.A. 1981. Organic soil reclamation/Mise en production des sols organiques. Station de recherche, Saint-Jean-sur-Richelieu, Québec. Bull. techn. 11.

Lamarre, M. 1981. Évaluation de lignées et cultivars de tabac à cigarette chez les producteurs. Le Briquet 51(1):22-25.

Lamarre, M. 1981. Application de drageonnicides au tabac à cigare. Le Briquet 51(2):15-17.

Lamarre, M. 1981. Usage de drageonnicides pour le contrôle des drageons du tabac à cigarette. Le Briquet 51(4):18-22.

Paradis, R.O.; Rivard, I. 1981. Insect and related pests of small fruit—Québec. Can. Agric. Insect Pest Rev. 58:38-39.

Paradis, R.O. 1981. Lutte rationnelle contre les ravageurs des pommiers au Québec/Pest Management Approach in Québec Apple Orchards. Station de recherche, Saint-Jean-sur-Richelieu, Québec. Bull. techn. 16. 31 pp.

Paradis, R.O.; Rivard, I.; Mailloux, M. 1981. Insect and related pests of pome fruit—Québec-Les ravageurs des pommiers. Can. Agric. Insect Pest Rev. 58:29-32.

Parent, L.E. 1981. Guidelines for peatland management in Eastern Canada/Guide d'utilisation des tourbières au Québec et dans les Maritimes. Station de recherche, Saint-Jean-sur-Richelieu, Québec. Bull. techn. 15. 38 pp.

Thériault, R. 1981. Nouvelles sources d'énergie utilisables à des fins de production agricole. Agriculture 38(1):29-35.

Vincent, C.; Boivin, G. 1981. La lutte intégrée contre les arthropodes ravageurs, Partie I—Historique des concepts. Agriculture 38(1):61-63.

ONTARIO REGION
RÉGION DE L'ONTARIO

Dr. J. J. Cartier

Dr. H. Baenziger

Mr. G. B. Matthews

EXECUTIVE OF THE ONTARIO REGION
L'EXÉCUTIF DE LA RÉGION DE L'ONTARIO

Director General
Directeur général
J. J. CARTIER, B.A., B.Sc., Ph.D.

Program Specialist
Spécialiste en programmes
H. BAENZIGER, Ing. Agr., M.Sc., Ph.D.

Chief, Institutes and Ontario Administration
Chef, administration des Instituts et de l'Ontario
G. B. MATTHEWS

PREFACE

The Ontario Region comprises nine responsibility centers: the research stations of Harrow, Delhi, Vineland, and Ottawa; the London and the Animal research centres; and the experimental farms at Smithfield, Kapuskasing, and Thunder Bay. Each has a specific mandate to carry out mission-oriented research in support of particular components of the agricultural industry or of a particular area. The regional staff totals about 880, of which about 180 are professionals. The total regional budget is approximately $29 million.

The Harrow Research Station has one of the most diverse research programs in the Region. Its program features field crops such as corn, soybeans, winter wheat, field beans, and burley tobacco, as well as horticultural crops such as tree fruits and vegetables. Most of these programs involve developing improved cultivars and superior production technologies. Emphasis is placed on improving integrated pest management technologies for the control of weeds, diseases, and insects.

The Delhi Research Station provides research support to the flue-cured tobacco industry in Ontario, Quebec, and the Maritimes. Improved cultivars and production technologies are being developed. In 1981 Delhi released three new cultivars, one for Ontario and two for the Maritimes. A research program on alternative crops for the tobacco soils was launched.

Integrated pest management for orchard and vegetable crops, grapes, ornamentals, and some forage crops is the focus of research at the Vineland Research Station, to reduce the use of chemical pesticides while maintaining crop productivity and produce quality. The Station also maintains a virus-free nuclear stock repository of strawberries, raspberries, and tree fruits.

The Ottawa Research Station conducts breeding programs in cereals, forages, soybeans, and some ornamentals, supported with research in plant pathology, physiology, entomology, cytogenetics, and grain quality. A center of excellence has been established in biotechnology to support plant-improvement programs of the future.

The Animal Research Centre conducts research in nutrition, physiology, and management of beef cattle; breeding, nutrition, and management of dairy cattle; nutrition, physiology, meat quality, and management of swine; breeding, nutrition, egg and carcass quality, disease resistance, and management of poultry; genetics, reproductive physiology, nutrition, and management of sheep; animal waste management; and food safety and nutrition. Vomitoxin contamination in winter wheat led to detailed research to establish contamination tolerance in feeds.

The London Research Centre concentrates on integrated pest management (protection), including biological control, and environmental quality. Research is directed toward reducing the dependence of the agri-food industry on chemical pesticides and toward assuring that human health and environmental safety are not adversely affected by pesticide use.

The Smithfield Experimental Farm program features plant breeding of apples and tomatoes, orchard and vegetable crop management (including integrated pest management), and some processing research.

The Kapuskasing Experimental Farm works with the Animal Research Centre and the Ottawa Research Station. Animal research aims at improving beef production systems for northern Ontario and western Quebec. Crop research attempts to improve crop production technolgoy.

The Thunder Bay Experimental Farm evaluates adaptation of forage, grain, and horticultural crops to the area.

During 1981 Dr. C. F. Marks, formerly Director at Delhi, was appointed Director of the Harrow Research Station. Dr. D. R. Menzies, a research scientist in engineering at Vineland, was appointed Director of the Vineland Research Station. Dr. P. W. Johnson, a research scientist in nematology at Vineland, was appointed Director of the Delhi Research Station.

Detailed information on the various programs may be obtained by writing to the establishments concerned or by addressing inquiries to Ontario Region Headquarters, Research Branch, Agriculture Canada, Central Experimental Farm, Ottawa, Ont. K1A 0C6.

J. J. Cartier

PRÉFACE

La région de l'Ontario compte neuf centres de responsabilité dont les stations de recherche d'Harrow, de Delhi, de Vineland et d'Ottawa, le Centre de recherche de London, le Centre de recherche zootechnique et les fermes expérimentales de Smithfield, de Kapuskasing et de Thunder Bay. Chacun a un mandat propre qui consiste à poursuivre des recherches thématiques pour le bénéfice de composantes données du secteur agricole et (ou) d'une région donnée. Le personnel de la région s'établit à environ 880 employés, dont 180 professionnels, et le budget se chiffre à près de 29 millions de dollars.

Le programme de la station de recherche d'Harrow est l'un des plus diversifiés de la région. Ses recherches portent sur les grandes cultures comme le maïs, le soja, le blé d'hiver, les haricots de grande culture et le tabac Burley ainsi que sur des cultures horticoles comme les arbres fruitiers et les légumes. La plupart de ces travaux visent entre autres à produire des cultivars améliorés et à mettre au point des techniques de production plus efficaces. Les chercheurs mettent l'accent sur le perfectionnement des méthodes de lutte intégrée contre les parasites afin d'enrayer les mauvaises herbes, les maladies et les insectes.

La station de recherche de Delhi effectue des recherches sur le tabac jaune qui profitent à l'industrie du tabac de l'Ontario, du Québec et des Maritimes. La production de cultivars améliorés et la mise au point de meilleures techniques de production sont au programme. En 1981, la station a mis sur le marché trois nouveaux cultivars, un pour l'Ontario et deux pour les Maritimes. Elle a aussi lancé un programme de recherche sur les cultures de rechange pour les terres à tabac.

Le programme de la station de recherche de Vineland met surtout l'accent sur les méthodes de lutte intégrée contre les parasites pour les vergers, les cultures maraîchères, les vignobles, les plantes ornementales et certaines cultures fourragères. Il vise à diminuer la quantité de pesticides chimiques utilisés tout en maintenant la productivité et la qualité du produit. La station conserve aussi un stock de matériel souche de fraises, de framboises et d'arbres fruitiers exempt de virus.

La station de recherche d'Ottawa s'occupe de l'amélioration des céréales et des cultures fourragères, du soja et de certaines plantes ornementales. La recherche englobe des domaines comme la pathologie et la physiologie végétales, l'entomologie, la cytogénétique et la qualité des grains. Un centre de haut calibre en biotechnologie a été mis sur pied pour appuyer les futurs programmes d'amélioration des végétaux.

Le Centre de recherche zootechnique effectue des recherches sur l'élevage, la nutrition et la physiologie des bovins de boucherie; l'élevage, la nutrition et l'amélioration des bovins laitiers; l'élevage, la nutrition, la physiologie et la qualité de la viande des porcs; l'élevage, l'amélioration, la nutrition, la qualité des œufs et des carcasses et la résistance aux maladies des volailles; l'élevage, la génétique, la physiologie de la reproduction et la nutrition des moutons; la valorisation et l'élimination des déchets d'origine animale, et l'innocuité et la valeur nutritive des aliments. La contamination du blé d'hiver par la vomitoxine a incité les chercheurs à entreprendre des recherches méthodiques afin d'établir les niveaux de tolérance dans les aliments du bétail.

Les principaux objectifs poursuivis par le Centre de recherche de London sont la lutte intégrée contre les parasites (protection) et surtout la lutte biologique, et la qualité de l'environnement. Les recherches visent à réduire l'utilisation des pesticides chimiques dans le secteur agro-alimentaire et à veiller à ce que l'organisme humain et l'environnement ne soient pas menacés par l'utilisation de pesticides.

Le programme de la ferme expérimentale de Smithfield porte sur l'amélioration de végétaux comme les pommes et les tomates, et sur la conduite des cultures de vergers et maraîchères (dont la lutte intégrée contre les parasites); elle poursuit aussi des travaux sur la transformation.

La ferme expérimentale de Kapuskasing travaille en collaboration avec le Centre de recherche zootechnique et la station de recherche d'Ottawa. Les recherches zootechniques visent à améliorer les systèmes de production de boeuf dans le nord de l'Ontario et dans l'ouest du Québec. Les recherches sur les cultures se concentrent sur l'amélioration des techniques de production.

La ferme expérimentale de Thunder Bay évalue la capacité d'adaptation des cultures fourragères, céréalières et horticoles dans la région.

En 1981, C.F. Marks, ancien directeur de la station de Delhi, a été nommé directeur de la station de recherche d'Harrow, D.R. Menzies, chercheur en génie agricole à Vineland, est devenu directeur de cette station et P.W. Johnson, chercheur en nématologie à Vineland, s'est vu attribuer le poste de directeur de la station de recherche de Delhi.

Il est possible d'obtenir de plus amples renseignements sur les programmes en écrivant à ces établissements ou en communiquant avec l'administration centrale de la région de l'Ontario, Direction générale de la recherche, Agriculture Canada, Ferme expérimentale centrale, Ottawa (Ont.) K1A 0C6.

J.J. Cartier

Animal Research Centre
Ottawa, Ontario

PROFESSIONAL STAFF

Administration

R. S. Gowe,[1] B.S.A., M.S., Ph.D.	Director
S. C. Thompson,[2] B.Sc., M.A., Ph.D.	Deputy Director
D. A. Leger,[3] B.Sc.	Assistant to the Director
T. E. Scott,[4] B.Sc.	Information Officer
D. L. Blakley, B.A.	Chief, Administration and Resources
J. R. Harrison, B.Sc.	Administrative Officer, Finance
G. R. Ford	Administrative Officer, Personnel

Scientific Support

K. G. Hilson, B.Sc., M.Sc.	Project Manager; Computer services
B. Ayotte	Systems and programming
L. McDonald,[5] B.A., L.L.B.	Systems and programming
H. M. Mucha	Systems and programming
A. Sabour[6]	Systems and programming
I. G. Smith, B.Math.	Systems and programming
S. P. Yanosik,	Library technician
K. E. Hartin, D.V.M.	Veterinarian

Animal Waste Utilization

N. K. Patni, B.Ch.E., M.Sc., Ph.D.	Program Chairman; Livestock waste utilization and farm pollution abatement

Trace Mineral and Beef Cattle Nutrition

M. Hidiroglou, D.V.M., Dip. Nutr.	Program Chairman; Vitamin D nutrition
M. Ivan,[7] Ing., M.Sc., Ph.D.	Nutrition and metabolism of trace minerals—Mn, Cu, Zn, Fe
D. M. Veira, B.Sc., M.Sc., Ph.D.	Beef cattle nutrition

Dairy Cattle Breeding and Production

A. J. McAllister, B.S. M.S., Ph.D.	Program Chairman; Dairy cattle breeding and production, applied quantitative genetics
T. R. Batra, B.V.Sc., M.V.Sc., Ph.D.	Dairy cattle breeding, applied quantitative genetics
A. J. Hackett, D.V.M., M.Sc., Ph.D.	Female reproductive physiology
A. J. Lee, B.Sc. (Agr.), Ph.D.	Dairy cattle breeding and production, applied quantitative genetics
C. Y. Lin, B.S., M.S., Ph.D.	Dairy cattle breeding, applied quantitative genetics
G. J. Marcus, B.A., Ph.D.	Maternal–embryonic physiological interactions
J. Nagai,[8] B.Sc., D.Agr.	Quantitative genetics—mice

Dairy Cattle Nutrition

F. D. Sauer, D.V.M., M.S., Ph.D.	Program Chairman; Rumen metabolism and nutrition
A. S. Atwal, B.Sc. (Agr.), M.Sc., Ph.D.	Forage evaluation and nutrition
J. D. Erfle, B.S.A., M.Sc., Ph.D.	Rumen metabolism and nutrition
K. J. Jenkins, B.S.A., M.Sc., Ph.D.	Calf nutrition
J. R. Lessard,[9] B.A., B.S.A., M.S., Ph.D.	Forage conservation and nutrition
S. Mahadevan, B.Sc., M.Sc., Ph.D.	Rumen physiology and ruminant nutrition
R. M. Teather, B.Sc., Ph.D.	Rumen microbiology

Swine Production

D. W. Friend, B.Sc., M.Sc., Ph.D.	Program Chairman; Sow and piglet nutrition
M. Coté,[10] B.Sc., M.Sc.	Swine nutrition
J. I. Elliot,[11] B.S.A., M.Sc., Ph.D.	Sow nutrition and artificial rearing
A. F. Fortin, B.Sc. (Agr.), Ph.D.	Carcass evaluation
D. G. Fraser, B.A., Ph.D.	Animal behavior—swine, sheep, cattle
H. A. Robertson,[12] B.Sc., Ph.D., C.Chem., F.R.I.C., F.R.S.E.	Female reproduction physiology
N. K. Sarkar, B.Sc., M.Sc., D.Sc.	Protein biochemistry

Poultry Breeding

J. S. Gavora, Ing., C.Sc.	Program Chairman; Egg stock breeding and management, broiler breeding, disease resistance genetics
J. R. Chambers, B.Sc., M.Sc., Ph.D.	Broiler breeding, goose research
R. W. Fairfull, B.Sc., M.Sc., Ph.D.	Egg stock breeding and management
R. S. Gowe, B.S.A., M.S., Ph.D.	Egg stock breeding and management
A. A. Grunder, B.S.A., M.Sc., Ph.D.	Broiler breeding, eggshell quality genetics, disease resistance genetics
K. G. Hollands, B.A., B.S.A., M.S.A.	Eggshell quality genetics, disease resistance genetics
C. P. W. Tsang, B.Sc., M.Sc., Ph.D.	Eggshell quality genetics

Poultry Nutrition

R. M. G. Hamilton, B.Sc. (Agr.), M.Sc., Ph.D.	Program Chairman; Nutrition and physiology, eggshell quality
N. A. G. Cave, B.Sc., M.Sc., Ph.D.	Amino acids and proteins, broiler breeder nutrition and management
I. R. Sibbald, B.Sc. (Agr.), M.Sc., Ph.D.	Avian energetics and feedingstuff evaluation

Sheep Production

D. P. Heaney, B.S., M.S., Ph.D.	Program Chairman; Nutrition and intensive management
L. Ainsworth, B.Sc., M.Sc., Ph.D.	Female reproductive physiology
P. S. Fiser, B.Sc., M.Sc., Ph.D.	Male reproductive physiology
G. A. Langford, B.Sc., M.Sc., Ph.D.	Male reproductive physiology
J. N. B. Shrestha, B.V.Sc.A.H., M.S., Ph.D.	Breeding and intensive management

Animal Feed Safety and Nutrition

H. L. Trenholm, B.Sc., Ph.D.	Program Chairman; Mycotoxins, toxicology
M. H. Akhtar, B.Sc., M.Sc., Ph.D.	Pesticide metabolism and residues
E. R. Farnworth, B.Sc., M.Sc., Ph.D.	Lipids and mycotoxins nutrition and biochemistry
T. S. Foster, B.Sc., M.Sc., Ph.D.	Pesticide metabolism and residues
J. K. Kramer, B.Sc., M.Sc., Ph.D.	Lipid chemistry and biochemistry

Departure

T. S. Foster, B.Sc., M.Sc., Ph.D. Retired December 1981	Pesticide metabolism and residues

VISITING SCIENTISTS

L. E. Liljedahl, D.Agr. Institute of Animal Breeding and Genetics, Swedish University of Agricultural Science, Uppsala, Sweden	Poultry breeding and genetics
M. J. Schang, Ing., M.Sc. Instituto Nacional de Tecnologia Agropecuraria, Pergamino, Argentina	Feedingstuff evaluation
B. Senft, B.Sc., M.Sc., Ph.D. Justus Liebig Universitat, Federal Republic of Germany	Immunoassay procedures

International Atomic Energy training fellow

B. Sakala National Council for Scientific Research, Lusaka, Zambia	Hormone radioimmunoassay procedures

Natural Sciences and Engineering Research Council postdoctorate fellows

M. K. Akbar, B.Sc., M.Sc., Ph.D. 1981–1982	Poultry breeding
L. Connor, B.Sc. (Agr.), M.Sc., Ph.D. 1981–1982	Reproductive physiology
D. Fitzpatrick, B.Sc., M.Sc., Ph.D. 1981–1982	Toxicology
P. M. Hocking, B.Agr., Ph.D. 1980–1982	Dairy cattle crossbreeding
C. Shorrock, B.Sc., M.Sc., Ph.D. 1980-1981	Beef cattle nutrition and management

Graduate students

F. LEVINE, B.Sc.	Reproductive physiology
J. C. SEGURA, C. Ing.	Poultry genetics

[1]On management leave, June 1981–February 1982.
[2]Acting Director, June 1981–February 1982.
[3]On French language training, April 1981–March 1982.
[4]May 1981–March 1982.
[5]Seconded from Systems and Consulting Division, Finance and Administration Branch.
[6]Transferred to Ministry of Transport.
[7]On transfer of work at Laboratoire de Maladies Nutritionnelles, l'Institut National de la recherche agronomique, Beaumont, France, from August 1980 to July 1981.
[8]On lecture tour in Japan, April–July 1981.
[9]Seconded to Reasearch Programs Coordination, Research Branch, November 1981–May 1982.
[10]Appointed 1 May 1981.
[11]Seconded to Management Accountability Directorate, September 1981–June 1982.
[12]On transfer of work at Animal Production and Health Section, Joint FAO/IAEA Division, International Atomic Energy Agency, Vienna, Austria, September 1981–August 1982.

INTRODUCTION

The Animal Research Centre (ARC) is the main Canadian centre for breeding and genetics research with dairy cattle, sheep, and poultry; it also has major research programs in the nutrition of dairy cattle, swine, sheep, beef, and poultry. ARC has research programs in animal waste utilization and management, trace minerals, ruminant digestive physiology, and animal feed safety and nutrition. The nine research program teams are multidisciplinary and are composed of scientists with a broad range of scientific knowledge. Both applied research and basic research that is directly related to the solution of the problem are carried out within these terms.

The Animal Research Centre continues to devote a large effort to studying the problems of intensively housed and managed cattle, sheep, swine, and poultry. Scientists of several disciplines—in particular, genetics, nutrition, and reproductive physiology—are involved in both multidisciplinary as well as unidisciplinary studies to resolve the numerous problems associated with improving the productivity of intensively housed animals.

Increasing emphasis is being placed on nutrition and feed safety with the addition of one biologist to the swine production program and with steps to recruit two scientists in feed safety.

Increasing effort is being devoted to the transfer of results from the researcher to the farmer-user. This is exemplified by the publication this year of two additional bulletins and a supplement to a previously published technical bulletin. Technical Bulletin No. 3, *Bioassays based on precision feeding of poultry*, describes a new technique developed at ARC that can be used to determine energy and amino acid and lipid content of animal feedingstuff. The new *ARC research farm* booklet describes, in detail, the facilities where ARC's programs are carried out, and the supplement to ARC Technical Bulletin No. 2, *The use of progestagen impregnated intravaginal sponges and artificial insemination in controlled reproduction programs in sheep*, outlines the potential applications of a new breeding system for commercial sheep production.

This annual report highlights research progress in the various scientific programs. The following significant advances were made in 1981: urea can effectively supplement the protein requirements of dairy cows and decrease feed costs when added to corn silage; rams given an 8-h day length for 2–3 mo before breeding improved lambing outcome in synchronized ewes; early breeding of gilts destined for market can increase swine production without placing increased demands on the existing breeding herd; replacement of skim-milk powder with soluble fish protein in calf milk replacers can result in a 40% saving in feed costs; meat and eggs from hens exposed to tetrachlorvinphos should not be marketed for 15 days after exposure; and estimation of daily milk yield and composition from a single morning or evening milk weight and sample is possible if the milking interval is known—this system can reduce costs in the genetic improvement of dairy cattle.

The staff at ARC act as the scientific authorities for a number of contract research programs and projects with private companies and universities. Contract research, together with government in-house research, plays an important role in solving problems facing Canadian agriculture. ARC supervised contract research programs in the areas of livestock feed from animal waste, swine nutrition, and mycotoxins.

Two of ARC's researchers received major honors in 1981. In April, a fellowship from the Japanese Society for the Promotion of Science was awarded to Dr. Jiro Nagai. This award recognized Dr. Nagai's significant contributions in the area of animal genetics. In August, the Poultry Science Research Award was presented to Dr. Robert Hamilton by the Poultry Science Association for outstanding research published in *Poultry Science*.

Detailed information on the research accomplishments, methodology, and results can be obtained from the publications listed at the end of this report. Reprints of these publications and copies of this report are available on request from the Animal Research Centre, Headquarters Building, Research Branch, Agriculture Canada, Ottawa, Ont. K1A 0C6.

S. C. Thompson
Acting Director

WASTE UTILIZATION

Bacteriological quality of tile drainage water from manured and fertilized cropland

In a 6-yr study on cropped fields, application of dairy cattle liquid manure by the rapid plow-cover technique did not have a large detrimental influence on the bacteriological quality of tile drainage water with respect to body-contact recreation compared with application of chemical fertilizer alone. Factors such as precipitation appear to have a greater influence on the bacteriological quality than does manure application. When animal manure was the sole source of fecal bacteria in the drainage water, the fecal coliform-to-fecal streptococci ratio seldom exceeded 4.0 but frequently exceeded 0.7.

Changes in nutrient content and properties of farm animal wastes during storage

A study to determine the variation in the composition and properties of liquid manures during storage was initiated to develop management guidelines to reduce losses and increase utilization of manure nutrients.

Dissolved inorganic nitrogen and phosphate concentrations in surface drainage from two agricultural watersheds

Annual applications of dairy cattle liquid manure in excess of 500 kg of nitrogen per hectare per year applied to corn-cropped land resulted in nitrate–nitrogen concentrations slightly in excess of 10 mg/L in shallow (1 m) groundwater. There was no apparent accumulation of ammonia nitrogen, *ortho*-phosphate, or potassium in groundwater.

Integrated food-waste processing and cattle feedlot operation

Under contract research, selected food-waste sources in southern Ontario were identified and their nutritional values established. A linear programming model was developed to produce least-cost waste-supplemented diets that would be nutritionally adequate to meet the requirements of feedlot cattle of different weight classes. Application of the model to alternative locations in Canada was considered.

Feasibility of ensiling waste-activated sludge (WAS) as a livestock nutrient source

Contract research was initiated to investigate the following: types and quantities of WAS suitable for ensiling with selected feed materials; physical, chemical, and microbiological quality of selected WAS before and after ensiling; and practical constraints for ensiling of WAS. The study is in progress.

TRACE MINERALS AND BEEF CATTLE NUTRITION

Metabolism of zinc (Zn) and molybdenum (Mo) in sheep

Two experiments with sheep were carried out to study the influence of picolinic acid on Zn metabolism. In the first experiment, sheep were infused with water into the duodenum and with picolinic acid into the rumen or duodenum. All the sheep were then intraduodenally dosed with ^{65}Zn. In the second experiment, sheep were intraduodenally infused with water or picolinic acid and then intravenously dosed with ^{65}Zn. The infusion with picolinic acid did not affect the fecal excretion or endogenous secretion of ^{65}Zn but increased the urinary excretion of the radioisotope and ruminal solubility of Zn. However, the duodenal and ileal solubilities of Zn were not affected by the treatment. It was concluded that an exogenous supplement of picolinic acid is not effective in promoting higher absorption of zinc in ruminant animals.

The absorption of labeled Mo compounds was studied in pairs of sheep exchanging digesta via reentrant duodenal cannulas. Thiomolybdate-^{99}Mo was rapidly absorbed from the rumen to circulate in plasma mainly in a protein-bound and trichloroacetic acid (TCA) insoluble form. The compounds were also absorbed from the small intestine, although some oxidation was evident. Initially, molybdate was poorly absorbed from the rumen. However, after several hours, plasma protein-bound, TCA-insoluble ^{99}Mo increased. This provides evidence of rumen thiomolybdate synthesis. The results indicate that thiomolybdates are absorbed directly from the rumen and, despite the sensitivity of the compounds to acid, some absorption from the small intestine occurs after passage through the abomasum. Rumen absorption could be a contributory factor to ruminant sensitivity to Mo compounds.

Studies of vitamin D in cattle

Calcium (Ca), magnesium (Mg), and phosphorus (P) status was evaluated in Shorthorn cattle during a 5-mo calf-nursing period following prepartum administration of 25-hydroxyvitamin D or vitamin D_3. The colostrum of the group that received 25-hydroxyvitamin D_3 was found to contain a higher percentage of Ca on the 2nd and 3rd day after parturition than did the colostrum of control cows or cows receiving vitamin D_3. There was no effect on Mg or P content of colostrum caused by prepartum treatment. Ca, Mg, and P concentrations were all high the 1st day, but declined by the 3rd day after parturition.

An analytical method was developed for evaluation of vitamin D in the blood. The assay could estimate levels less than 1 ng/mL of blood plasma.

Fat cow syndrome

Assays of free amino acids in the plasma of 12 cows with the fat cow syndrome (FCS) and 17 healthy cows were carried out for 6 wk after parturition. Plasma concentrations of phenylalanine, histidine, glutamic acid, and lysine in the cows with FCS were significantly higher than in healthy cows. In contrast, the cows with FCS exhibited a lower concentration of threonine, glutamine, asparagine, and citrulline. It is suggested that the reported changes in the plasma amino acids of cows with FCS could be a reflection of the metabolic alteration in the control mechanism of gluconeogenesis.

Beef production in the northern claybelt area of Ontario

The 2nd yr of a 2-yr study on finishing bulls or steers with varying grass silage-to-barley ratios was complete. Hereford × Shorthorn bulls or steers were fed from weaning to slaughter on direct-cut formic acid grass silage to appetite plus high-moisture barley at levels of dry matter (DM) of 0, 0.5, 0.95, or 1.35 kg/100 kg liveweight. During the first 154 days on test, these levels of barley supplement resulted in daily liveweight gains of 0.95, 1.05, 1.21, and 1.27 kg, with feed-to-gain ratios of 6.8, 6.6, 5.95, and 5.88. The animals required 241, 220, 196, and 178 days to reach market weight, respectively. Bulls and steers were marketed when they had 8–10 mm of fat over the loin as measured by ultrasound. Results averaged across all diets showed that it took bulls 2 days longer to attain the required degree of fatness but they had increased weight gains (9.5%), improved feed efficiency (8.9%), and a heavier carcass (7.7%). Both bulls and steers attained a carcass grade of A_1 or A_2 regardless of diet.

The potential of including Avoparcin, an experimental feed antibiotic, in a free-choice salt–mineral mixture was examined with growing yearling heifers on both indoor winter feeding and on pasture during summer. Avoparcin was included in the mineral mix to give a theoretical intake of 400 mg/day; intake was below expected, because the inclusion of Avoparcin mixture depressed free-choice mineral consumption (26.7 versus 33.6 g/day). During winter feeding, the Avoparcin group gained about 10% faster (0.53 versus 0.48 kg/day) and had better feed efficiency (DM at 12.3 versus 13.45 kg per kilogram of gain). Silage intake during this period was very similar for both groups. Pasture gains for the Avoparcin group were approximately 10% greater. The inclusion of this feed additive in a free-choice mineral supplement is a practical method of administering it to pasture animals and to all roughage-fed animals.

Ciliate protozoa and rumen function

A diet containing corn silage and ground corn (1:1) with urea (11.4% crude protein) was fed twice a day to six sheep fitted with duodenal reentrant and rumen cannulas for two periods. During the first period, defaunation was attempted using only phenol ethylene oxide. Defaunation was complete in three sheep and partial in three sheep in which a reduced population (14×10^4) of the small protozoa *Entodinium simplex* was observed. During the second period, the sheep were innoculated with a normal population of protozoa, which became well established (16.8×10^5/mL). Apparent stomach digestion of organic matter (OM), acid detergent fiber, and starch was lower when the protozoa were eliminated or reduced, although this was only significant for OM (46.2 versus 52.5%) and starch (85.5 versus 89.2%). Duodenal flow of nonammonia nitrogen (NAN) was greater when protozoa were eliminated or reduced (NAN at 1.34 versus 1.13 g per gram of N intake or NAN at 2.13 versus 2.07 g per 100 g of DM intake). There was no difference in the bacterial N flow per 100 g of OM digested in the stomach.

DAIRY CATTLE BREEDING AND PRODUCTION

National cooperative dairy cattle breeding project (NCDCBP)

Additional studies have been completed that further characterize the foundation purelines of the project. Progeny of highly selected bulls from breed groups in the Ayrshire-based A line (Research Branch, Finnish, U.S. and Canadian Ayrshire, Brown Swiss, and Norwegian Red) and the Holstein-based H line (Research Branch, U.S. and Canadian Holstein) have been compared for body-weight change pattern, disease occurrence, and cost of health care through three lactations.

H-line cows were larger and about 50 kg heavier than A line cows at all ages (577 versus 524 kg at third calving), but the results suggest that all cows underwent a similar pattern of weight changes. There was evidence of more rapid growth during first lactation of the H-line cows. Cows during first lactation lost weight (20 kg) from calving to 56 days postpartum. Weight loss during this period was greater for older first calvers, whereas younger first calvers gained more weight from 56 days postpartum onward.

Greatest incidence of disease and cost (drug cost and veterinary charges) occurred for the reproduction, metabolism, and mastitis categories. A-line cows had greater reproduction and digestion disorder costs, whereas H-line cows incurred greater mastitis costs, but total costs were similar for both lines. Greater total health-care costs for progeny groups in both lines were incurred in later lactations. Total cost of medical care for progeny groups in the H-line were similar. Among A-line groups, daughters of the two Brown Swiss bulls had the least cost of medical care, whereas the Research Branch and Canadian Ayrshire groups had the greatest.

Differences in cost of disease per lactation among H-line progeny groups were significant for reproduction cost in first lactation and mastitis cost in fourth and later lactations. Daughters of the U.S. Holstein bulls had significantly lower reproduction costs for the first lactation and higher mastitis costs for fourth and later lactations. Health costs (but not mastitis costs) associated with reproduction and digestion differed among the A-line progeny groups. Daughters of the Brown Swiss bulls had the lowest reproduction cost per lactation, and the U.S. Ayrshire-sired progeny had the highest. Canadian Ayrshire progeny had the greatest cost for digestion problems.

Semen characteristics, fertility, body weights, withers height, and heart girth were compared among H-line, A-line, and crossbred bulls (H × A and A × H). The bulls were sons and grandsons of the sires used in the pureline foundation phase. Semen from A-line and H × A crossbred bulls had the highest concentration and motility, but volume per ejaculation was greatest for A-line bulls and least for H × A bulls. A × H and H-line bulls were heavier, larger in heart girth, and taller at the withers up to 238 days of age, but bulls in all lines were similar in weight and size at 350 days of age. Intraline phenotypic correlations among semen traits, body weights, and measurements were generally low. Heart girth was indicated as a relatively good predictor of semen quality ($r = 0.26$). Crossline bulls had higher conception rates than pureline bulls (H × A 59.5%, A × H 52.0%, H 50.0%, A 46.1%). The semen quality traits were not significantly correlated with conception rate.

Breeding studies using record of performance (ROP) data

The recording of milk production and milk quality is necessary for genetic improvement of Canadian dairy cattle. Records are being used to evaluate the genetic value of cows and bulls and to make culling decisions. More rapid genetic improvement could be made for the same program cost if milk recording could be expanded without increasing staff.

Using either a.m. or p.m. milk weights and milk samples instead of both a.m. and p.m. weights and a composite sample would increase the number of herds tested by the same inspector. Accurate factors for estimating daily milk yield and composition for either a.m. or p.m. data are being developed from a research project of the Animal Research Centre in cooperation with ROP personnel and 50 ROP dairy herds. Protein percentage ratios (a.m. or p.m. to the daily total) were not affected by milking interval, and either a.m. or p.m. milk samples reflect the true daily percentage of protein. Milking interval and stage of lactation jointly influence the ratio factors for estimating daily milk yield and fat percentage from a single a.m. or p.m.

milking. The time interval from the previous milking must be verified if daily milk yield and percentage of fat are to be accurately estimated from either a.m. or p.m. data. Electronic time-recording devices are available but expensive. With a known milking interval, however obtained, it is now possible to estimate daily milk yield and composition from either a.m. or p.m. milk weights and milk-sample analysis.

Detection of estrus in the postpartum dairy cow

Four methods of estrus detection were incorporated into the management system for the dairy cattle housed year-round in a loose-housing barn. The methods were as follows: the herdsmen (H) in which the cows were observed closely by the herdsmen during two 1-h periods at 6:00 a.m. and 3:00 p.m. daily; the use of an androgenized female (A) in which a hormonally treated female fitted with a chin ball marker was used to detect cows in estrus; a group (C) in which estrus was detected and recorded throughout the working day by the workers in the barn; and KaMaR heat detectors plus an androgenized female (K). The H and A methods were superior to the C and K methods in detecting estrus in postpartum cows. Between the day of parturition and 55 days postpartum, detection rates were 53 and 49% versus 46 and 36%, respectively. Among the three genetic lines, the proportion of cows detected in estrus was similar. Many KaMaR heat detectors were falsely triggered when rubbed against the bars dividing the comfort stalls. Milk samples were taken twice weekly for progesterone analysis to monitor estrus cycles. The milk progesterone profiles showed that the majority of cows began to have ovarian activity between 2 and 3 wk postpartum and confirmed estrus in those cows detected by the above four methods.

Pilot genetic studies with mice and computer simulation

Genetic principles fundamental to the current National cooperative dairy cattle breeding project, but difficult to examine experimentally, were investigated using mice and computer simulation.

Hybrid vigor (heterosis) occurs in the first filial cross (F_1) when parental lines (strains) are crossed. Heterosis in lifetime production in female mice was examined using lines selected for increased milk production (MP and MQ), lines selected for increased adult weight (WP and WQ), and unselected control lines (CP and CQ) in two populations of different origin (P and Q). Body weight of litters raised to weaning (day 18) by a female during the 155 days after mating was defined as lifetime production. Litter size was not adjusted at birth. Mean lifetime production for the six lines was 507.5 g (MP), 496.2 g (CQ), 479.6 g (WQ), 439.0 g (CP), 437.6 g (MQ), and 380.9 g (WP). Heterosis in lifetime production for F_1 populations measured as deviation from the mean of the two parental lines was 29.3% (MP × MQ, F_1 cross of MP sire and MQ dam), 28.7% (CQ × CP), 16.4% (WQ × WP), and 13.0% (WP × MP). Number of lactations during 155 days, a major force in determining lifetime production within lines showed heterosis: 8.1% (MP × MQ), 1.6% (WQ × WP), −0.4% (MQ × MP), −1.2% (CQ × CP), and −8.6% (WP × MP). The following conclusions were reached: the size of heterosis in lifetime production varied among F_1 crosses; heterosis in the number of lactations during 155 days was not necessarily positive; and crosses of lines selected for increased milk production showed significant heterosis for both characteristics.

Factors affecting maintenance of pregnancy

Previous research with sheep has demonstrated the production by the early sheep embryo of prostacyclin and prostaglandin E_2. The embryo also appears to initiate prostaglandin synthesis by the uterus with implications for maintenance of pregnancy. Early findings indicate that the unattached cow embryo synthesizes a small amount of prostaglandin from exogenous substrate, whereas the uterus does not. Procedures are being modified to permit critical evaluation of interactions that occur early in pregnancy between the embryo and the cow.

DAIRY CATTLE NUTRITION

Urea in dairy cattle rations

Urea can effectively supplement the protein requirements of dairy cows when added to corn silage at ensiling. An experiment was designed to determine milk production when urea, added to corn at ensiling, was used to increase 12.5% crude protein (CP) soybean meal or fishmeal-supplemented diets to 15.5%

total CP. Urea-supplemented rations were compared with a 12.5% CP-negative control ration formulated with soybean meal and with two positive control rations supplemented with either soybean or fishmeal to contain 15.5% total CP. Concentrates and corn silage were fed ad libitum as a complete feed. For 2 wk prepartum and 4 wk postpartum all animals were fed the 15.5% CP ration supplemented with soybean meal before they were fed their allocated diets. Data from weeks 2–4 were used as a covariate. Solids-corrected milk (SCM) production during weeks 13–16 for diets containing 12.5% CP was 21.2 kg/day and for 15.5% diets containing soybean meal alone it was 22.6% kg/day. With the urea silage diet, daily milk yield was 23.3 kg/day; for fishmeal plus urea silage it was 23.9 kg/day; and for an all fishmeal diet it was 18.1 kg/day. The SCM and persistency of milk production was lowest for the all fishmeal diet at 13–16 wk postpartum. This was not reflected in reduced feed intake for that diet. The percentage of milk fat and the daily fat production were significantly higher in the all soybean meal supplemented (3.97%) and the urea silage supplemented diets (4.26%) than in the 12.5% CP control (3.44%) and the all fishmeal diet (3.39%). The concentration of rumen ammonia was significantly lower on the 12.5% CP control diet than on the other four diets. Fishmeal adversely affected performance, and its rumen bypass characteristics appear to be variable depending on conditions during processing. An experiment is under way to combine the feeding of soybean, which has been treated with formaldehyde to increase its rumen bypass characteristics, with urea silage.

Forage evaluation

Current research in this area is designed to establish the relative economic returns from various methods of preserving forages that are suited to weather conditions in Ontario and Quebec.

In a preliminary study, two hays (mixtures of alfalfa and grasses) were stored in large round bales placed end to end in a row and two rows were placed side by side. After the bales had been stored over two winters the badly weathered outer layers were removed, with a loss of about 20–25% DM. The remaining material was ground with a tub grinder and fed to adult cows. The low-protein hay (9.6% CP) contained 57.4% total digestible nutrients (TDN), and its DM consumption was 1.61% of body weight. The high-protein hay (14.1% CP) was less palatable and was fed mixed with corn silage (72:28%, DM basis). This mixture gave a TDN value of 53.4% and a maximal DM consumption of 1.66% of body weight. Both the hays would meet energy and CP requirements of adult cows. The maximal DM intake of low- and high-protein hays was 2.36 and 2.59% of body weight of wethers.

An experiment was designed to test the possibility of storing large round bales in a pyramid form (i.e. piling three, two, and one bales in bottom, middle, and top rows) and to compare this method with silage systems. Alfalfa from the first cut was harvested in mid bloom (17–18% DM) and sorted in the three following forms: direct-cut silage treated with 85% formic acid (0.36% of fresh weight) to lower the pH close to 4 (treatment A); low-moisture silage wilted for 50 h to an average DM content of 38.5% (treatment B); large round bales on the 12th day after cutting because of poor weather conditions (treatment C). Estimated DM yields at the time of storage were 3621, 4135, and 2016 kg/ha for treatments A, B, and C, respectively. A somewhat higher yield for B in comparison with A resulted from harvesting closer to the ground. The very low yield of C was a reflection of poor weather conditions. Forage from second-cut alfalfa harvested at 7 wk of regrowth was also stored as large round bales as (treatment D), and DM yield was estimated at 1835 kg/ha. Weather conditions were reasonable and second-cut hay was baled on the 3rd day.

The large round bales in treatments C and D were covered with thick plastic sheets. This protection was useful against early rains, but later, high winds tore the plastic sheets, and in cold weather it became impossible to keep the bales covered. The outer layers of the large round bales were damaged by water, and mold growth was evident (especially in bales from the first cut). Average consumable DM recovery from mid-September to mid-December 1981 was 76.2 and 80.8% for bales from first- and second-cut alfalfa, respectively. Thus it seems that storing in pyramids covered with plastic is not sound management practice.

Calf nutrition

The soluble fish protein (SFP) milk-replacer work was completed, with eating-quality evaluation of roasts from vealers fed SFP indicating no reduction of tenderness, juiciness, or cooking quality. Some off-flavor in roasts was detected at very high dietary intake levels of SFP. Test results showed that replacement of skim-milk powder with SFP can result in a 40% saving of feed cost; these results were passed to industry through a scientific publication, a short bulletin, and a paper published in *Feedstuffs*. As a result of calf-feeding studies with SFP and work by others, a new protein-ingredient series is now being produced in which SFP is used in starter rations for calves, pigs, lambs, turkeys, and mink.

Work was successfully completed on developing a pretreatment for milk and milk replacers to prevent their subsequent clotting in the stomach of young calves. Studies are under way using this method to determine the importance of rennet-casein clotting in preruminant calves on digestibility and utilization of dietary protein and lipids.

Other work is under way on attempting to upgrade poor-quality proteins for calf milk replacers by incorporating the limiting amino acids by the Plastein reaction.

Determination of rumen bypass protein

For the routine in vitro determination of feed protein degradability, stable rumen protease preparations of reproducible enzyme activity are needed both by researchers and by the feed industry. Currently, such rumen protease preparations are not available. The use of other proteases and cellulases in these assay procedures does not represent the enzymes in the rumen. Methods have been developed for the preparation of rumen proteases and cellulases in high yield (about 90% of the activity in freshly collected rumen fluid). These activities are stable in dry-powder form for a year, and quantities up to 100 g can be prepared in one day. Since amino acid-deaminating enzymes present in the rumen fluid are destroyed during the preparation of the protease powders, measurement of protein degradability is very much simplified to determine liberated amino acids. Moreover, because rumen cellulase is also kept active in these preparations, the need for the addition of cellulases from other sources (usually of fungal origin) is eliminated. These results are expected to greatly improve the existing methods of determining feed protein degradability in vitro.

pH and rumen fermentation

The artificial rumen was used to study the effect of pH on rumen fermentation with a single diet containing approximately 10% crude fiber. Over the range of pH from 7 to 5, the rate of production of volatile acids decreased from 160 to 100 mmol/day per litre. This decrease was mainly a result of the decrease in production of acetic acid and to a lesser extent butyric, isovaleric, and isobutyric acids. The rate of production of propionic, valeric, and caproic acids increased over the same pH range, resulting in an acetic to propionic acid ratio of 4.2 at pH 7 and 0.8 at pH 5. Lactic acid production was constant at 0.03 mmol/day until pH was decreased to 5.5, when it rose threefold. The production of methane was between 80 and 10 mmol/day per litre at pH 7 and 6.5. There was a significant decrease in methane production below pH 6, and production ceased at pH 5. Low methane production at pH 5.5 was accompanied by a trace of hydrogen. At pH 5 the production of hydrogen was 40 mmol/day per litre.

SWINE PRODUCTION

Reproductive performance and meat production of gilts bred at puberty and restricted in feed intake

Gilts bred at puberty (first estrus) were fed 1.2 kg daily until day 84 of pregnancy, 1.4 kg to day 99, and then 1.6 kg to farrowing. Some litters were weaned at 21 days, others within 12 h of birth. A number of unbred gilts were treated in the same way as the bred gilts, and gilts selected at 91 kg were used as market-weight controls. Carcasses of the weaned gilts were lighter than those of the unbred gilts and had less backfat thickness than the lighter market weight controls. There were no significant differences in flavor, juiciness, and tenderness of loin and ham between the market-weight carcasses and those of the other groups.

Nutrition and management of the neonatal pig

Contract research with the University of Guelph determined the interrelationship

between methionine and cystine and phenylalanine and tyrosine in the piglet; the interaction commonly accepted for growing pigs could not be established, and if present it was likely to be more complex for the piglet than previously thought.

The feasibility of using a hydrolyzed fish-protein concentrate to replace part of the soybean meal content of creep and starter diets is being examined. The study involves continuing the pigs through the growing–finishing phases to market weight (91 kg), and examining the carcasses for consumer acceptability (flavor, juiciness, and tenderness).

Removal of piglets from the sow at farrowing for a period of up to 10 h, and their return to her as a litter on completion of farrowing can provide a better opportunity for their survival and subsequent viability than conventional farrowing practices. A comparison between these two methods showed the removed piglets to be significantly lighter at 10 h, but there was no difference in weight at 7 days of age.

The behavior and welfare of the sow-sucking piglets is strongly associated with the number of piglets weaned per sow per year. The ability of the newborn piglet to survive under natural rearing conditions depends mainly upon adequate and regular suckles. A study was initiated to determine the relationship between sucking position and teat quality (in terms of milk production), and performance and survival of piglets.

Relationship between backfat thickness and total body fat in boars

The relationship between backfat and body fat was determined with 48 Yorkshire boars averaging 91 kg bodyweight and 147 days of age. Linear regression coefficients for the percentage of carcass fat, viscera, and head were 0.40, 0.005, and 0.004 respectively, indicating that for each unit increase in backfat thickness, the percentage of carcass fat increases by a factor of 0.4; percentage of fat in the viscera and head, however, remains virtually the same.

Reproductive physiology

Studies on the interaction between the embryo and the mother in relation to maternal recognition and maintenance of pregnancy in the pig have been extended to an investigation of the influence of fetal estrogen on corpus luteum function. Preliminary findings indicate the occurrence of specific receptors for estrogen in luteal cells early in pregnancy (day 10).

POULTRY BREEDING

Selection and flock management studies in egg-producing chickens

Six long-term selected strains and their 30 reciprocal crosses were tested. The selected strains originated from three base populations, two from each base. For an array of traits important in egg stocks, this diallel-cross experiment showed that strain-cross performance includes significant additive and nonadditive genetic effects.

Selection (additive genetic effects) of the strains before crossing resulted in improved performance of the crossbred birds by the following: 45 more eggs in a full year; 20 days earlier sexual maturity; 3% lower adult mortality; 3.6 g larger eggs; and 430 g less feed consumed per kilogram of egg laid. Nonadditive genetic effects, particularly heterosis and differences between reciprocal crosses, were large and highly significant for most traits. Heterosis in crosses of unrelated strains improved performance by the following: 18 more eggs in a full year; 18 days earlier sexual maturity; 1% lower adult mortality; 1.1 g larger eggs; and 170 g less feed consumed per kilogram of egg laid. When closely related strains (derived from the same base population) were crossed, heterosis was also substantial although smaller. It improved performance by the following: 12 more eggs per year; 2 days earlier sexual maturity; 0.5% lower mortality; 0.5 g larger eggs; and 140 g less feed consumed per kilogram of egg laid.

Mean differences between reciprocal crosses of pairs of strains were large, emphasizing the importance of genes on the large sex chromosome in chickens and the possibility of maternal effects. Between related strains, reciprocal differences averaged 10 eggs, 2 days of sexual maturity, 5% in mortality, 0.5 g in egg size, and 110 g feed consumed per kilogram of egg laid. Between unrelated strains, reciprocal differences averaged 9 eggs, 3 days in sexual maturity, 5% in mortality, 1 g in egg size, and 60 g feed consumed per kilogram of egg laid.

The effects of comb removal (dubbing), or removal of both the comb and wattles (dubbing and dewattling) were evaluated in three

studies. Birds were dubbed and dewattled in the laying house at 255–260 days old, in the rearing house at 118 days old, or dubbed only at hatch. Dubbing and dewattling in the laying house adversely affected egg production (–0.8 eggs to 273 days) and rate of egg production in the early part of the year, but significantly improved egg size (0.2 g at 225 days and 0.3 g at 450 days) and shell strength. Dubbing at hatch had some benefits, such as lower mortality, earlier sexual maturity, increased egg size, and better egg quality (higher Haugh units), when compared with dubbing and dewattling at 118 days. Birds dubbed at hatch were more uniform than those not dubbed or dewattled.

Increasing the length of time eggs are saved for hatch can benefit breeding programs by reducing hatch effects and increasing management efficiency. For 2 yr, hatching eggs were saved over 3 wk and labeled by the week. Eggs from the first 2 wk were placed in plastic bags and the air was evacuated or flushed with nitrogen. Age of hatching egg had no significant effects except for a small adverse effect on egg weight (–0.04 g at 240 days and –0.5 g at 450 days) and egg quality (Haugh units –0.7 at 240 days) in birds hatched from eggs stored more than a week; this procedure is therefore recommended.

A mathematical model describing the egg production curve would allow breeders to predict production from partial records. Exponential models from both McMillan and Wood and linear regression were fitted to individual hen records as well as to mean production of groups of hens in a cooperative study with the Swedish University of Agricultural Sciences in Uppsala and the University of Guelph. McMillan's model gave the best results, explaining, on average, 71% of the variation in monthly egg production of individual hens and 97% of this variation for groups of hens.

Genetics of poultry meat production

Sire and dam genetic base populations were previously synthesized from commercial broiler parents. These are being used to evaluate the need to select for either feed efficiency, leanness, or both, in order to improve production efficiency and meat quality of broilers. Genetic parameters of broiler progeny of the base populations were estimated. Heritabilities for the two base populations and sexes combined were as follows: 28-day body weight, 0.31; percentage of abdominal fat at 50 days, 0.65; 28–42 day feed consumption, 0.33.

Associations of 12 plasma traits with up to 18 production traits were studied in nine sire-type and seven dam-type stocks of commercial broiler parents. Blood samples were obtained from 55- to 60-week-old birds. Correlations between plasma and production traits failed to reveal meaningful associations. For production traits, commercial source and sex were major predictors of variation but surprisingly, sire and dam-type stocks did not differ significantly.

The accuracy of predicting broiler abdominal fatness from a special caliper measurement was tested. The caliper measurement variation accounted for up to 25% of the variation in abdominal fatness. Later, technical improvements suggested prediction could be increased to 50%. This technique could replace the costly carcass evaluation now used in broiler breeding.

The effect of carcass fatness on the sensory properties of cooked broiler meat was tested by comparing fatness measured in one-half of the carcass to sensory properties of the other half (taste-panel evaluation). Sensory properties of white meat were not altered by carcass fatness. Dark meat was slightly improved by higher carcass fat, but fatness differences accounted for less than 10% of the variation in sensory rating of dark meat.

The influence of final body weight and carcass fatness on 28–48 day broiler feed efficiency was examined. Over 50% of the differences in feed efficiency were associated with variation in final weight and carcass fatness. Feed efficiency was positively related to final weight but negatively associated with fatness.

Disease resistance genetics

Green muscle disease, a degenerative disease, is known to attack only a deep-lying breast muscle of adult meat-type chickens and turkeys. The location of this muscle prevents positive identification in the live animal. Work is in progress to develop a practical, indirect method of identifying broiler chickens susceptible to or affected by this disease. A promising method under investigation utilizes creatine kinase, an

enzyme found in the blood. This enzyme appears to be excessively elevated in susceptible birds for several days following a brief, forced, vigorous wing exercise. Research is continuing on this method of identifying the disease and on the role genetics may play in its expression.

Additional research was carried out in cooperation with the Animal Diseases Research Institute (ADRI) and with other institutions. Two Ottawa inbred lines (GF and GH) were shown to be void of the known major histocompatibility (*B*) haplotypes. Specific reagents for their new, tentative haplotypes were produced at the University of Alberta. One of these haplotypes was originally present in the GF line, which is highly resistant to Marek's disease (a viral, thymus-dependent lymphoproliferative disease of chickens). This haplotype remained associated with such resistance in the F_2 generation resulting from a cross of the two lines and may be useful in commercial poultry breeding. Another study conducted with the University of Northern Illinois confirmed the superior resistance to Marek's disease of commercial birds bearing the B^{21} histocompatibility haplotype.

To extend the earlier findings on negative effects of subclinical lymphoid leukosis (an egg-transmitted, viral, bursa-dependent, lymphoproliferative disease of chickens) on production traits, a computer-simulation study was conducted with a United States Department of Agriculture researcher at Purdue University. It showed that individual selection for high egg production should be more effective than family selection in removing infected individuals from populations.

Eradication of lymphoid leukosis by techniques developed in cooperation with ADRI is being attempted in an ARC isolation facility. Tests conducted to date show that the flocks in the facility are free from the virus.

Eggshell quality

Uterine adenosine triphosphatase (ATPase), an enzyme implicated in calcium transport across membrane walls, and shell weight of partly formed eggs 12 h after oviposition were investigated in relation to shell quality in two strains of old hens and one strain of young hens. Although strain differences were observed for uterine ATPase activity, there was no evidence of an association with shell quality. The weight of the shell plus the membrane of partly formed eggs differed between the two strains of older hens; it was heavier for the group of older hens laying eggs with the higher specific gravity. In young hens, the shell weight of partly formed eggs was correlated with specific gravity and nondestructive deformation tests of eggs. Thus, by 12 h postoviposition, strong-shelled eggs have already deposited more layers of shell than weak-shelled eggs.

Further investigation of estrogens in relation to shell quality showed that young laying hens (31 wk old) that were repeatedly immunized against their own steroid sex hormone estradiol laid eggs with lower specific gravity and had a higher incidence of shell-less eggs than nonimmunized controls. This supported previous observations, which suggested that estrogens influence regulation of shell formation.

Geese

Carcasses of the Chinese, Hungarian, and Pilgrim strains, as well as a synthetic of the three strains, were compared for carcass weights, portions, and chemical composition. The synthetic and Hungarian carcasses were the heaviest and lightest, respectively, and males were heavier than females. No significant differences were observed for percentage of fat pad. The Hungarian geese had the highest percentage of breast and the Chinese had the highest percentage of leg of eviscerated carcass weight. No strain differences were evident for chemical composition of carcasses, but males had a greater percentage of moisture, protein, nitrogen, and ash and less ether-extractable fat than females.

POULTRY NUTRITION

Meat-type birds

Restricted feeding procedures are used to control body weight in broiler breeder stock; however, the optimum age to impose feed restriction is not known. Production of hatching eggs was higher and feed per egg lower when skip-a-day restricted feeding was initiated at 21 rather than 35 days of age. However, restricted feeding from 1 day old, induced by either dietary coconut fatty acids or dietary glycine for 21 days, gave no improvement in performance over skip-a-day restriction from 21 days of age.

Provision of a prelayer diet containing protein at 180 g/kg from 20 to 28 wk old had

no effect on age at sexual maturity, initial egg weight, or number of eggs when compared with feeding a conventional breeding diet (150 g/kg) from 23 wk onward.

The size of eggs at the onset of lay is commonly inadequate for hatching. When exposed to an ahemeral lighting program of 27-h days, meat-strain hens laid heavier eggs (2.3 g more) than did hens subjected to a conventional 24-h daylight cycle. Production of egg mass was not increased, however, and the number of eggs was reduced. Age at sexual maturity was delayed by the ahemeral lighting program.

Analytical technique

A method that transforms an entire bird (including feathers, beak, and claws) to a dry, free-flowing, homogeneous powder was developed. The carcass of the bird is autoclaved, reduced to a homogenous slurry in a food blender, and then freeze-dried. Aliquots of the dry product are reduced to a powder with a mortar and pestle. The method is less laborious and causes no greater loss of moisture, gross energy, ether extract, or nitrogen than conventional techniques.

Mineral assay

The theoretical basis for extending the true metabolizable energy (TME) bioassay technique to individual minerals was developed. Assays for minerals will complete the new system for poultry feed evaluation. However, very precise analytical techniques will be required to measure the minerals.

Measurement of metabolizable energy

In the TME bioassay, pooling excreta samples before analysis has no effect on the TME values obtained and saves time; however, ignoring variation among birds makes the standard errors of mean TME values subject to bias. The potential magnitude of the bias for an individual feedingstuff is too large to be discounted in a research laboratory.

Comparative studies of methodology for measurement of bioavailable energy in poultry feeds continued. Traditional bioassays using glucose and whole-diet replacement were made with chicks. The results obtained indicate that the apparent metabolizable energy (AME) values obtained with diet replacement were higher than those for the method using glucose substitution. Because feed intake of chicks influenced the AME values, it was not possible to express these values in terms of TME. Similar AME values were obtained when acid-insoluble ash or chromic oxide was used as an indicator, but the insoluble ash, which is naturally present in feedingstuff, required less time to measure and no special equipment.

Shell structural theory and avian eggshell strength

Regression analysis of data for variables associated with shell strength of eggs from geese, turkeys, Japanese quail, and domestic hens (both brown- and white-shell producers) produced much higher correlation coefficients between shell strength and other egg variables (e.g. shell thickness, egg weight) among the five species ($r > 0.92$) than within species ($r < 0.44$). Also, the slope of the regression equation between nondestructive deformation was found to be positive among species and negative within species. These results indicate that the main factors of the engineer's theory of shell structural strength only partly explain the variation in eggshell strength within a species.

Comparison of methods for measuring egg specific gravity

Two methods are used extensively to determine the specific gravity (SG) of eggs. These are flotation of eggs in saline solutions of increasing SG and the loss in weight when eggs are immersed in water; the latter is known as Archimedes' method. Data from measurements on 1494 eggs indicated that the errors associated with the two methods are similar and much smaller than the variance in SG among eggs. Therefore, the flotation method, which enables the measurement of more eggs per unit time, is satisfactory for most applications.

SHEEP PRODUCTION

Development of synthetic sire and dam strains

The rearing of the hysterectomy-derived nucleus for ARC's minimum disease flock, the selection of animals (100 rams and 600 ewes) for the initial matings, and the first breeding were completed. Matings were designed to maintain the genetic base and maximize

conception rates during the initial step of reestablishing flock numbers.

The development phase for the present synthetic strains has been completed, and an in-depth review of the genetics input to the program resulted in the following revised and updated objectives: to continue development of specialized sire and dam strains of sheep; to obtain estimates of genetic parameters and changes among synthetic and control strains, and time trends in those differences; to monitor correlated responses on production characteristics not under selection; to develop a fertility index for ram lambs to improve the reproductive rate of their daughters; and to establish a phenotypic standard to evaluate conformation characteristics among strains.

Controlled lamb production

Ewes were treated for 12 days with intravaginal sponge pessaries containing 60 mg medroxyprogesterone acetate (MAP, Upjohn) or 40 mg fluorogestone acetate (FGA, G. D. Searle) in conjunction with an intramuscular injection of 500 IU of pregnant mares' serum gonadotropin (PMSG) at sponge removal. The treatments were equally effective for induction of a synchronized estrus, but sponge losses for MAP sponges were 17.3% compared with only 1% for FGA sponges. Further studies are necessary to determine whether high sponge loss is a consistent feature of MAP sponges.

Further field trials in Ontario on the use of FGA sponges plus PMSG for induction of a synchronized estrus in commercial sheep flocks showed that maintenance of proven mature rams under an 8-h day length for 2–3 mo before breeding in the spring improved the lambing outcome of synchronized ewes. Hand mating of synchronized ewes 48 and 60 h after sponge removal also appeared to have a beneficial effect on the lambing outcome. A ram stud has been established at United Breeders, Guelph, Ont., and small-scale field trials using fresh semen to breed synchronized ewes in commercial sheep flocks are in progress.

Similar field trials in Newfoundland, conducted over a 3-yr period, also demonstrated that FGA sponge treatment can be applied successfully under commercial flock conditions. In the Newfoundland trials, farm-to-farm variation was observed in reproductive performance of ewes synchronized and bred during the estrous season, but no differences among farms were apparent during the anestrous season.

Evaluation of carcass merit

Carcass characteristics of 161 ram lambs from the three synthetic and two control strains ranging in age from 115 to 129 days were studied. Sire strain carcasses graded higher than dam strain carcasses and yielded a higher percentage of total lean meat product as well as a higher percentage of lean meat product in the loin, rack, and leg. In general, carcass characteristics such as weight, grade, dressing percentage, and backfat thickness favored the dam strains over the Finnish Landrace control strain, whereas there was no major difference between the sire strain and the Suffolk control strain.

Artificial insemination (AI)

The effect that seasonal photoperiods had on the quality of ram semen were studied in relation to its freezability. It was shown that better freezability during periods of decreasing light is related to the higher quality of ram semen collected at these times. Actual survival of ram semen at freezing temperatures was affected by photoperiod only moderately, and its decrease during March and April coincided with an increased incidence of abnormal spermatozoa present in the ejaculates. Under decreasing day lengths the number of spermatozoa per ejaculate, ejaculate volume, motility of fresh and frozen semen, survival at freezing temperatures, osmotic pressure, and pH were increased, and number of abnormal spermatozoa decreased. The osmotic pressure of the semen was positively correlated with freezability parameters, pH was negatively correlated with concentration, and the incidence of abnormal sperm was negatively correlated with motility and freezability parameters.

Previous research indicated that the cervix is a major barier to good fertility using AI. In response to this, a new bioassay was developed to measure the penetration of ram sperm through cervical mucus. This assay provides a new way of studying the basic parameters of sperm motility in cervical mucus as well as potentially useful methods and pharmacological agents that stimulate passage of ram sperm through the cervix. Work has been facilitated by the use of frozen bovine cervical mucus. By freezing mucus, a large homogenous supply can be stored over long periods of

time without significantly affecting the ability of sperm to penetrate it.

ANIMAL FEED SAFETY AND NUTRITION

Mycotoxins

Mycotoxins are produced by molds on plant crops in the field and during storage. When ingested by livestock and poultry, decreased animal performance or deleterious health effects may occur.

During the past few years, mycotoxin contamination has been of concern to the feed and livestock industries in Eastern Canada. Vomitoxin contamination of wheat crops resulted in a government recommendation to the industry to restrict the use of wheat in farm animal rations. Health officials banned the use of contaminated wheat in certain human foods. Zearalenone contamination of corn reported in southern Ontario may also be present at levels that can decrease animal performance.

Research studies on mycotoxins emphasized work on the toxicology and nutritional effects of the mycotoxins zearalenone and vomitoxin.

Analytical work continued on development of sensitive high-performance liquid chromatographic (HPLC) methods for detecting free zearalenone and metabolites (α- and β-zearalenol and conjugates) in blood and urine. Experiments are in progress on the metabolism of zearalenone in livestock species.

A series of feeding trials were completed with swine and poultry using different levels of 1980 Ontario white winter wheat naturally contaminated with vomitoxin at 1.0 mg/kg. Feed refusal and decreased weight gains were observed in pigs, but not poultry. No changes were observed in egg production, although slight decreases in egg weights were noted.

The research contract with the Sibbald Group of Deloitte Haskins and Sells Associates was completed. The report documented cases of livestock illness attributed to mycotoxin-contaminated feedstuffs. The survey results were presented at the American Oil Chemists' Society Symposium on mycotoxins held in New Orleans.

Program scientists collaborated with investigators at several Agriculture Canada institutes as part of a multidisciplinary Research Branch approach to mycotoxins.

Fats and oils

Experiments to verify a computer model that related heart lesion incidence in male rats fed high-fat diets to the level of particular dietary fatty acids showed that by changing the dietary fatty acid pattern, the incidence of necrotic lesions in the heart could be altered. In particular, as the level of dietary saturated fatty acids increased, heart lesion incidence decreased. This was true for both low erucic acid rapeseed (LEAR) oil and soybean oil. However, other factors, such as the method of oil extraction and processing and the composition of the basal diet, have also been questioned as to their role in the etiology of heart lesions.

In an experiment to compare methods of extraction, rapeseed was prepared by the normal commercial process and by a pilot plant hexane extraction procedure. The pilot plant oil was not refined or deodorized, and temperatures were kept below those used in the commercial process. The general fatty acid patterns of the two oils were similar, but the commercial oil showed evidence of *cis–trans* isomerization of the polyunsaturated fatty acids. Oil extracted in the pilot plant had a lower sulfur and phosphorus content and was more colored than the commercially processed oil. Although the rats receiving the pilot plant extracted oil ate significantly more, there was no difference in the incidence of heart lesions between the pilot plant oil group of rats and the commercial oil group. This result supported the hypothesis that the fatty acid pattern of an oil influences heart lesions. The oils obtained from the two processes differed in some chemical characteristics, but because their fatty acid patterns were the same, rats consuming the oils showed the same incidence of heart lesions.

The nutritional adequacy of the basal diet that has been used in rapeseed feeding trials has recently been questioned. This situation arose from the fact that the experimental diets used in rat feeding–heart lesion experiments contained 20% fat. At this high fat level, the requirement for other nutrients could be increased. It was suggested that the 20% casein component of the diet provided inadequate amounts of the amino acid methionine. An experiment was carried out in which the amounts of the lipotropic factors methionine and choline were varied in a 20% casein–20% fat diet to determine their effects on nutritional and pathological parameters.

The data indicated that supplementation with methionine improved growth of the rats, but other parameters such as total liver lipid, urine metabolites to measure methionine status, liver oil–red-O stain score, and, in particular, heart lesion incidence were not influenced by the level of choline or methionine in the diet. It was concluded that methionine supplementation to the 20% casein–20% fat diet was not a factor in the etiology of heart lesions.

A project to determine the roles of linoleic and linolenic acids in growth and development has been approved. Experiments are planned to determine the function performed by these two essential fatty acids in fat metabolism in the growing animal. Animals will be fed adequate and essential fatty acid-deficient diets to determine which body organs are sensitive to these fatty acids. Competition between essential and nonessential fatty acids in metabolic enzyme systems will be determined.

Pesticide metabolism

Fenvalerate. A high-performance liquid chromatography method has been developed for the analysis of fenvalerate and two of its metabolites. The method involves extraction with hexane, followed by cleanup on a Sep-pak before analysis on a μ-Porasil column. The method has been successfully used for identification and quantification of fenvalerate, 2-(4-chlorophenyl)-3-butyric acid and 3-phenoxybenzoic acid in chicken excreta from an in vivo study with laying hens. Approximately 1.5% of the total dose of fenvalerate was found in the excreta. The two acids, identified as methyl esters, were the major metabolites; a few unidentified metabolites were also found. Analyses and quantitation are continuing.

Trichlorfon. Studies of trichlorfon with soluble fractions from chicken and cow liver homogenates and buffer (pH 7.4) showed that the insecticide was metabolized in both dichlorvos (DDVP) and desmethyl trichlorfon. The rate of degradation of trichlorfon in enzyme systems was greater than that in buffer. Cow liver soluble fraction metabolized trichlorfon at a slightly higher rate than the chicken liver preparation.

Tetrachlorvinphos. Analyses of biological samples from an in vivo study of tetrachlorvinphos with laying hens showed that detectable amounts of the insecticide are deposited in abdominal fat, kidney, and liver while the hens are on experimental diets but that the insecticide is gradually depleted when the hens are removed from this diet. Excreta of the treated birds contained two major metabolites (25% desmethyl tetrachlorvinphos and 30.5% 2,4,5-mandelic acid), in addition to 1% of the insecticide. On the basis of these analyses, it has been recommended that eggs or meat of birds, or both, treated with tetrachlorvinphos not be marketed for at least 15 days after the last treatment.

Cypermethrin and decamethrin. Decamethrin (labeled and unlabeled) has been synthesized. Spectroscopic and physical data have been recorded. Methods have been developed for isolation, cleanup, and quantitation by gas chromatography of cypermethrin, decamethrin, and two of their metabolites. This information can be used in the positive identification of residues and metabolites of these important pyrethroids in samples from in vitro and in vivo studies. Studies are in progress on the in vitro metabolism with liver homogenate preparations.

PUBLICATIONS

Research

Akhtar, M. H.; Foster, T. S. 1981. Tetrachlorvinphos metabolism in laying hens. J. Agric. Food Chem. 29:766-771.

Batra, T. R.; Fiser, P. S.; McAllister, A. J. 1981. Effect of glycerol equilibration time on survival of bull sperm frozen in pellets. Can. J. Anim. Sci. 61:63-65.

Batra, T. R.; Lee, A. J. 1981. Extending records in progress to 305-day lactation production by using 1965 USDA and modified extension factors. Can. J. Anim. Sci. 61:523-529.

Buckley, D. J.; St. Amour, G.; Fairfull, R. W. 1981. An improved electronic gauge for measuring egg albumen height. Poult. Sci. 60:777-780.

Cave, N. A. G. 1981. The effect of diurnal programs of nutrient intake on performance of broiler breeder hens. Poult. Sci. 60:1287-1292.

Cave, N. A. G. 1981. The effect of intermittent light on carcass quality, feed efficiency and growth in broilers. Poult. Sci. 60:956-960.

Chambers, J. R.; Gavora, J. S.; Fortin, A. 1981. Genetic changes in meat-type chickens in the last twenty years. Can. J. Anim. Sci. 61:555-563.

Culley, J. L. B.; Phillips, P. A.; Hore, F. R.; Patni, N. K. 1981. Soil chemical properties and removal of nutrients by corn resulting from different rates and timing of liquid dairy manure applications. Can. J. Soil Sci. 60:35-46.

Eisen, E. J.; Nagai, J.; Bakker, H.; Hayes, J. F. 1980. Effect of litter size at birth on lactation in mice. J. Anim. Sci. 50:680-688.

Erfle, J. D.; Mahadevan, S.; Sauer, F. D. 1981. Relationship between adenylate energy change, rumen volatile fatty acid concentrations, and rates of production and dry matter digestibility in the cow. J. Dairy Sci. 64:634-642.

Fahmy, M. H.; Friend, D. W. 1980. Factors influencing, and repeatability of the duration of farrowing in Yorkshire sows. Can. J. Anim. Sci. 61:17-22.

Fairfull, R. W.; Boughton, D.; Corbett, N.; Gavora, J. S.; Kaplansky, M.; Slin, P. 1981. The use of portable data entry terminals for recording egg production. Poult. Sci. 60:2349-2352.

Farnworth, E. R.; Trenholm, H. L. 1981. The effects of acute administration of the mycotoxin zearalenone to female pigs. J. Environ. Sci. Health. B 16:239-252.

Fiser, P. S.; Ainsworth, L.; Langford, G. A. 1981. Effect of osmolality of skim-milk diluents and thawing rate on cryosurvival of ram spermatozoa. Cryobiology 18:399-403.

Fiser, P. S.; Langford, G. A. 1981. Effect of sodium pentobarbital and storage time of preservation of ram spermatozoa motility at 5°C. Can. J. Anim. Sci. 61:847-851.

Fortin, A.; Chambers, J. R. 1981. Specific gravity of the carcass and of its parts as predictors of carcass composition in broiler chickens. Poult. Sci. 60:2454-2462.

Fortin, A.; Reid, J. T.; Maiga, A. M.; Sim, D. W.; Wellington, G. H. 1981. Effect of level of energy intake and influence of breed and sex on growth of fat tissue and distribution in the bovine carcass. J. Anim. Sci. 53:982-991.

Foster, T. S.; Akhtar, M. H. 1981. High-performance liquid chromatography of fenvalerate. J. Chromatogr. 216:303-311.

Friend, D. W.; Elliot, J. I. 1981. Drop-farrowing as an aid to sow-management. Can. J. Anim. Sci. 61:1071-1074.

Friend, D. W.; Lodge, G. A.; Elliot, J. I. 1981. Effect of energy and dry matter intake on age, body weight and backfat at puberty and on embryo mortality in gilts. J. Anim. Sci. 61:429-439.

Grunder, A. A.; Guyer, R. B.; Buss, E. G.; Clagett, C. O. 1981. Effect of estradiol on calcium and calcium binding in serum of thick and thin-shelled lines of chickens. Poult. Sci. 60:2776-2781.

Grunder, A. A.; Thompson, B. K.; Hollands, K. G.; Hamilton, R. M. G. 1981. Shell strength changes by three hours after oviposition and influence of polyurethane foam covered cage floors. Poult. Sci. 60:1140-1144.

Hackett, A. J.; Batra, T. R. 1981. Reproduction in three genetic lines of dairy cattle housed in a total confinement system. Can. J. Comp. Med. 45:339-342.

Hackett, A. J.; Langford, G. A.; Robertson, H. A. 1981. Fertility of ewes after synchronization of estrus with prostaglandin $F_2\alpha$ and artificial insemination. Theriogenology 15:599-603.

Hackett, A. J.; Robertson, H. A.; Wolynetz, M. S. 1981. Effects of prostaglandin $F_2\alpha$ and pregnant mares' serum gonadotrophin (PMSG) on the reproductive performance of fluorogestone acetate-PMSG-treated ewes. J. Anim. Sci. 53:154-159.

Hackett, A. J.; Wolynetz, M. S. 1981. Comparison of natural mating and artificial insemination on reproductive performance of three strains of sheep housed in total confinement. Can. J. Anim. Sci. 61:907-912.

Hamilton, R. M. G. 1981. The effects of strain, age, time after oviposition, and egg specific gravity on acid-base balance in White Leghorn hens. Poult. Sci. 60:1944-1950.

Hamilton, R. M. G.; Cipera, J. D. 1981. Effects of dietary calcium levels during brooding, rearing, and early laying period on feed intake, egg production, and shell quality of White Leghorn hens. Poult. Sci. 60:349-357.

Hamilton, R. M. G.; Grunder, A. A.; Thompson, B. K.; Hollands, K. G. 1981. Relationship between blood ionized calcium levels and shell strength of eggs laid by White Leghorn hens. Poult. Sci. 60:2380-2384.

Hamilton, R. M. G.; Thompson, B. K. 1981. The effects of storage duration, nondestructive deformation, quasi-static compression strength, impact fracture strength, and specific gravity of eggs from White Leghorn hens. Poult. Sci. 60:1798-1801.

Hidiroglou, M. 1980. Manganese and reproductive function of ruminants. Pages 265–281 *in* M. Anke, ed. 3rd Symp. on Trace Elements. Karl Marx University Press, Leipzig, G.D.R.

Hidiroglou, M.; Ivan, M.; Ihant, M. 1981. Silicon in plasma of sheep. Am. J. Vet. Res. 42:138-139.

Hidiroglou, M.; Knipfel, J. E. 1981. Maternal-fetal relationships of copper, manganese and sulfur in ruminants: A review. J. Dairy Sci. 64:1637-1647.

Hidiroglou, M.; Thompson, B. K. 1980. Serum alkaline phosphate activity in beef cattle. Ann. Rech. Vet. 11:381-389.

Hidiroglou, M.; Thompson, B. K.; Ho, S. K.; Proulx, J. G. 1981. Hypomagnesaemia in beef cows wintered in Ontario. Can. J. Comp. Med. 45:124-129.

Hidiroglou, M.; Williams, C. J. 1981. Transfer of tritium-labeled vitamin D_3 and 25-hydroxy-vitamin D_3 in ovine placenta. Am. J. Vet. Res. 42:140-141.

Ho, S. K.; Hidiroglou, M.; Proulx, J. G. 1980. A silent hypocupremic condition in beef cows fed grass silage and the efficacy of sequestered copper to prevent its occurrence. Ann. Rech. Vet. 11:233-239.

Ivan, M. 1981. Distribution of radiomanganese in the rumen of sheep. Can. J. Physiol. Pharmacol. 59:76-84.

Ivan, M.; Johnston, D. W. 1981. Re-entrant cannulation of the small intestine in sheep: Cannula and surgical method. J. Anim. Sci. 52:849-856.

Ivan, M.; Veira, D. M. 1981. Effect of dietary protein on the solubilities of manganese, copper, zinc and iron in the rumen and abomasum of sheep. Can. J. Anim. Sci. 61:955-959.

Jenkins, K. J. 1981. Pepsin and pancreatin supplementation of calf-milk replacer containing soy protein. Can. J. Anim. Sci. 61:469-476.

Jenkins, K. J.; Emmons, D. B.; Lessard, J. R. 1981. Some in vitro observations on factors affecting rennet (chymosin) clotting of calf milk replacers. Can. J. Anim. Sci. 61:393-401.

Jenkins, K. J.; Kramer, J. K. G.; Emmons, D. B. 1981. Digestion of fat in calves fed milk replacers prepared by homogenization or low-pressure dispersion. J. Dairy Sci. 64:1965-1971.

Jenkins, K. J.; Mahadevan, S.; Emmons, D. B. 1980. Susceptibility of proteins used in calf milk replacers to hydrolysis by various proteolytic enzymes. Can. J. Anim. Sci. 60:907-914.

Marcus, G. J. 1981. Prostaglandin formation by the sheep embryo and endometrium as an indication of maternal recognition of pregnancy. Biol. Reprod. 25:56-64.

Marcus, G. J.; Hackett, A. J.; Robertson, H. A. 1981. Ram induced synchronization of estrus in confined ewes under controlled lighting. Can. J. Anim. Sci. 61:833-837.

Martin, A. H.; Fredeen, H. T.; Weiss, G. M.; Fortin, A.; Sim, D. W. 1981. Yield of trimmed pork product in relation to weight and backfat thickness of the carcass. Can. J. Anim. Sci. 61:299-310.

Nagai, J.; Hunsaker, W. G.; Wolynetz, M. S. 1981. A system for recording maternal behaviour of lactating mice. Zwierzeta Lab. 18:53-57.

Nagai, J.; Lee, A. J. 1981. Relationship between growth before mating and lifetime production in eight lines of mice. Z. Versuchstierk. D. 23:24-29.

Patni, N. K.; Phillips, P. A.; Hore, F. R.; Culley, J. L. B. 1981. Groundwater quality near concrete manure tanks and under heavily-manured cropland. Can. Agric. Eng. 23:37-43.

Phillips, P. A.; Culley, J. L. B.; Hore, F. R.; Patni, N. K. 1981. Pollution potential and corn yields from selected rates and timing of liquid manure applications. Trans. Am. Soc. Agric. Eng. 24:139-144.

Price, M. A.; Aherne, F. X.; Elliot, J. I.; Lodge, G. A. 1981. The effect of age at puberty on growth and carcass quality at market weight in the gilt. Anim. Prod. 33:159-164.

Sarkar, N. K.; Lodge, G. A.; Elliot, J. I. 1981. Effect of skim-milk supplement high in protein and low in fat to suckled pigs. Can. J. Anim. Sci. 61:507-509.

Sauer, F. D.; Erfle, J. D.; Mahadevan S. 1981. Evidence for an internal electrochemical proton gradient in *Methanobacterium thermoautotrophicum*. J. Biol. Chem. 256:9843-9848.

Sibbald, I. R. 1981. Metabolic plus endogenous energy and nitrogen losses in adult cockerels: The correction used in the bioassy for true metabolizable energy. Poult. Sci. 60:805-811.

Stevenson, I. L.; Voisey, P. W.; Hamilton, R. M. G. 1981. Scanning electron microscopy of fractures in eggshells subjected to the puncture test. Poult. Sci. 60:89-97.

ANIMAL RESEARCH CENTRE, OTTAWA, ONT.

Thompson, B. K.; Hamilton, R. M. G.; Voisey, P. W. 1981. Relationship among various egg traits relating to strength, among and within five avain species. Poult. Sci. 60:302-310.

Trenholm, H. L.; Warner, R. M.; Farnworth, E. R. 1980. A high performance liquid chromatographic method using fluorescence detection for the quantitative analysis of the mycotoxin zearalenone and α-zearalenol in blood plasma. J. Assoc. Off. Anal. Chem. 64:302-310.

Tsang, C. P. W.; Grunder, A. A.; Hollands, K. G. 1981. Estrogen sulfates in the plasma of White Leghorn laying hens. Poult. Sci. 60:2548-2550.

Tyrrell, H. F.; Bull, L. S.; Garrett, W. M.; Sibbald, I. R.; Smith, R. R. 1981. Nutritional energetics of domestic animals and glossary of energy terms. National Academy Press, Washington, D.C.

Veira, D. M.; Ivan, M. 1981. Digestion of corn and alfalfa silages in the stomach and small intestine of sheep prepared with two re-entrant cannulas. Can. J. Anim. Sci. 61:113-119.

Miscellaneous

Ainsworth, L.; Heaney, D. P.; Langford, G. A.; Hackett, A. J.; Fiser, P. S.; Shrestha, J. N. B. 1981. The use of progestagen impregnated intravaginal sponges and artificial insemination in controlled reproduction programs for sheep/Utilisation d'eponges vaginales impregnees de progestagene et insemination artificielle dans les programmes de controle de la reproduction chez les ovins. Suppl. ARC Tech. Bull. No. 2. Agric. Can. Anim. Res. Centre. 9 pp.

Akhtar, M. H.; Foster, T. S. 1981. Excretion and retention of tetrachlorvinphos by laying hens. Canadex 450.60.

Andrews, R. I.; Thompson, B. K.; Trenholm, H. L. 1981. A national survey of mycotoxins in Canada. Lipids 58:989A-991A.

Cave, N. A. 1981. Intermittent lighting enhances broiler carcasses. Canadex 452.

Cave, N. A. 1981. Programmed feeding of broiler breeder hens. Canadex 450.50.

Cave, N. A. 1981. Whole grain for broiler breeder replacement stock. Canadex 450.50.

Egan, A. R.; Ivan, M. 1979. Re-entrant fistulation of the small intestine. Pages 836–837 *in* Y. Ruckebusch and P. Thivend, eds. Digestive physiology and metabolism in ruminants. Proc. 5th Int. Symp. on Ruminant Physiology. MTP Press Ltd.

Fairfull, R. W.; Gowe, R. S. 1980. Feed consumption and feed efficiency in selected and control strains of egg stocks under long term selection for a complex of economic traits. Pages 230–245 *in* A. Robertson, ed. Proc. Symp. Selection Experiments in Laboratory and Domestic Animals. Commonwealth Agricultural Bureaux, Farnham Royal, Slough, U.K.

Farnworth, E. R.; Trenholm, H. L. 1981. Effects of mycotoxin zearalenone on young female pigs. Canadex 440.666.

Grunder, A.; Hollands, K. G.; Tsang, C. P. W. 1981. Relationship between plasma estrogen levels and blood calcium or shell quality. Poult. Sci. 60:1661-1662.

Hamilton, R. M. G. 1981. The relationship between acid-base balance in the laying hen and egg shell strength. *In* Proc. 1981 Georgia Nutr. Conf. pp. 8-16.

Hamilton, R. M. G.; Fairfull, R. W. 1981. Force molting of laying hens. Canadex 450.10.

Hamilton, R. M. G.; Grunder, A. A.; Thompson, B. K.; Hollands, K. G. 1981. Changes in egg shell strength up to 21 days after oviposition. *In* Quality of eggs. Proc. 1st Eur. Symp. Spelderholt, The Netherlands. pp. 104-110.

Hidiroglou, M.; Williams, C. J.; Hackett, A. J. 1981. Plasma levels of some minerals during the estrous cycle of ewes. J. Dairy Sci. (Suppl. 1) 64:155.

Hollands, K. G.; Grunder, A. A.; Gavora, J. S. 1981. Induction by exercise of deep pectoral myopathy and associated changes in plasma creatine kinase levels in female turkeys. Poult. Sci. 60:1669.

Hollands, K. G.; Grunder, A. A.; Williams, C. J.; Gavora, J. S.; Chambers, J. R.; Cave, N. A. G. 1981. Degenerative myopathy in meat type poultry: Its effect on production traits in chickens and its identification in live turkeys. *In* Quality of poultry meat. Proc. 5th Eur. Symp. Spelderholt, The Netherlands. pp. 337-344.

Jenkins, K. J. 1981. Adding proteolytic enzymes to calf milk replacers containing soybean proteins. Canadex 401.50.

Jenkins, K. J.; Sauer, F. D.; Emmons, D. B.; Larmond, E. 1981. Soluble fish protein in milk replacers give good calf performance. Canadex 401.64.

Leger, D. A.; Gowe, R. S. 1981. Animal Research Centre Research Farm. ARC unnumbered publ. Agric. Can. Anim. Res. Centre. 110 pp.

Mahadevan, S.; Erfle, J. D.; Sauer, F. D. 1979. Solubility may not be a good indicator of protein degradability in the rumen. Feedstuffs 51(51):20.

Nagai, J.; McAllister, A. J. 1981. Long-term production of dairy cattle: A view from mouse experiments. Can. Agric. 3:29-30.

Sibbald, I. R. 1981. Advantages of the TME system. Proc. Minnesota Nutr. Conf., St. Paul, MN. pp. 113-118.

Sibbald, I. R. 1981. Amino acid availability. Poult. Dig. 39:604.

Sibbald, I. R. 1981. Basic assumptions of the true metabolizable energy (TME) bioassay. Poult. Sci. 60:1733.

Sibbald, I. R. 1981. Bioassays based on precision feeding of poultry/Dosage biologique en cage métabolique chez la volaille. ARC Tech. Bull. No. 3. Agric. Can. Anim. Res. Centre. 34 pp.

Sibbald, I. R. 1981. Energy values of feeding fats for poultry. Feedstuffs 53(20):19-20.

Sibbald, I. R. 1981. Energy values of feeding fats for poultry. Poult. Dig. 40:262-266.

Sibbald, I. R. 1981. Sistema para la evaluacion de las materias primas en las aves. XIX Symposium Cientifico, Seccion Espanola de la Associacion Mundial de Avicultura Cientifica, Barcelona. pp. 337-361.

Sibbald, I. R. 1981. The true metabolizable energy and related bioassays. Proc. Minnesota Nutr. Conf. St. Paul, MN. pp. ' -112.

Sibbald, I. R. 1981. Water the most important nutrient. Poult. Dig. 39:542.

Thompson, S. C. 1980. The economics of dairy farming in Canada. Can. Vet. J. 21:113-118.

Trenholm, H. L.; Cochrane, W. P.; Cohen, H.; Elliot, J. I.; Farnworth, E. R.; Friend, D. W.; Hamilton, R. M. G.; Neish, G. A.; Standish, J. F. 1981. Survey of vomitoxin contamination of the 1980 white winter wheat crop in Ontario, Canada. *In* Proc. Walter A. Pons Jr. Memorial Symp.: Mycotoxins. Lipids 58:992A-994A.

Tsang, C. P. W.; Grunder, A. A.; Gavora, J. S. 1981. Effect of active immunization against estradiol on egg shell quality, production and sexual development of the chick embryo. Poult. Sci. 60:1745.

ANIMAL RESEARCH CENTRE, OTTAWA, ONT.

Research Centre
London, Ontario

PROFESSIONAL STAFF

Administration

H. V. MORLEY, B.Sc., Ph.D.	Director
J. A. COLEMAN	Administrative Officer
J. GIESBRECHT,[1] B.A., B.L.S.	Library Area Coordinator (Ont.)
D. E. H. DREW,[1] B.Sc., M.L.S.	Librarian

Mode of Action of Selected and Potential Insect Control Agents

W. CHEFURKA, B.Sc., M.Sc., Ph.D.	Section Head; Biochemistry
E. J. BOND, B.S.A., M.Sc., Ph.D.	Fumigation—toxicology
T. DUMAS, D.C.E., M.Sc.	Analytical chemistry
R. M. KRUPKA, B.A., M.A., Ph.D.	Biochemistry
T. T. LEE, B.Sc., Ph.D.	Plant biochemistry and tissue culture
T. NAGAI, M.E., M.Sc., D.Sc.	Neurophysiology
E. B. ROSLYCKY, B.Sc., M.Sc., Ph.D.	Microbiology
A. N. STARRATT, B.Sc., Ph.D., F.C.I.C.	Chemistry—attractants and repellents
R. W. STEELE, B.Sc., Ph.D.	Neurochemistry
A. VARDANIS, B.Sc., M.Sc., Ph.D.	Biochemistry

Mode of Action of Selected and Potential Plant-Pathogen Control Agents

E. W. B. WARD, B.Sc., M.Sc., Ph.D.	Section Head; Plant pathology—phytoalexins
D. A. CUPPELS, B.A., M.S., Ph.D.	Phytobacteriology—microbial physiology
G. LAZAROVITS, B.Sc., M.Sc., Ph.D.	Plant pathology—fungicides
D. M. MILLER, B.Sc., M.Sc., Ph.D.	Biophysical chemistry—fungicide selectivity

A. Stoessl, B.Sc., Ph.D., F.C.I.C.	Organic chemistry—phytoalexins and toxins
G. A. White, B.A., M.Sc., Ph.D.	Biochemistry—fungicides

Soil Pesticides

C. R. Harris, B.A., M.A., Ph.D.	Section Head; Insect toxicology
B. T. Bowman, B.S.A., M.Sc., Ph.D.	Soil physical chemistry
R. A. Chapman, B.Sc., M.Sc., Ph.D.	Analytical organic chemistry
D. G. R. McLeod, B.S.A., M.S., Ph.D.	Physiology
J. R. W. Miles, B.Sc.	Analytical chemistry
J. R. Robinson, B.S.A., M.S.A., Ph.D., F.C.I.C.	Chemistry—radioisotopes and mass spectrometry
J. H. Tolman, B.Sc., M.Sc., Ph.D.	Applied entomology
A. D. Tomlin, B.A., M.Sc., Ph.D.	Pesticide ecology
C. M. Tu, B.Sc., M.Sc., Ph.D.	Microbiology

Departure

G. D. Thorn, B.Sc., M.A., Ph.D., F.C.I.C. Retired May 1981	Organic chemistry—fungicides

VISITING SCIENTISTS

S. S. Gnanamanickam, B.Sc., M.Sc., Ph.D., 1980–	Plant pathology—disease physiology
K. R. Jennings, B.Sc., Ph.D., 1981–	Pesticide physiology
A. S. Murty, M.Sc., Ph.D., 1980–1981	Pesticide residues
M. D. Zhou, M.S., 1981–	Plant physiology

Graduate students

D. Classen, M.Sc., 1981–	Plant pathology
M. A. J. Finkelman, B.Sc., M.E.Sc., 1979–	Biochemistry
E. Gnidec, B.Sc., 1980–	Biochemistry
L. Ho, B.S., M.S., 1980–1981	Plant physiology
R. S. MacDonald, B.Sc., 1980–	Insect toxicology

[1]Seconded from Libraries Division, Finance and Administration Branch.

INTRODUCTION

This report summarizes highlights of research carried out during 1981 at the London Research Centre in support of Departmental objectives in environmental quality and crop protection. The Centre was established in 1951 to investigate the problems created by the introduction of synthetic organic pesticides. Present research programs reflect the current health and environmental concerns regarding the agricultural use of pesticides by concentrating research efforts in integrated pest management (IPM) and environmental toxicology.

The IPM objective comprises four research activities. The pest management activity is aimed at developing IPM procedures, including biological control, for agriculturally and economically important insect pests. Research on stored products is directed toward the investigation of environmental and insect resistance problems and the development of more efficient fumigation procedures leading to a minimum of pesticide residues. The third activity concerns research on alternative pest control strategies. Studies on insects are aimed at identifying specific areas for attack so that pest control in the future does not rely upon the use of broad-spectrum toxicants. Research on natural plant defense mechanisms in disease-resistant and susceptible agriculturally important crops has the objective of using natural defense mechanisms by chemical manipulation or in the breeding of resistant varieties. The last activity under the IPM objective concerns research on systemic fungicides. Studies are carried out on the efficacy of systemic fungicides and on the plant pathological, biochemical, biophysical, and structural parameters of fungicide activity and resistance.

Research on environmental toxicology has three areas of activity. The first deals with the effect of pesticides on nontarget soil invertebrates and agriculturally important soil microorganisms. The second is concerned with the determination of the behavior, persistence, and environmental fate of pesticides and their movement through the environment. The third is concerned with establishing the mode of action of growth regulators and toxicants by carrying out studies on insects and plants related to vital processes of growth and development.

This report records only the highlights of our accomplishments for 1981; more detailed information can be obtained from the publication titles listed at the end of this report. Copies of this report, reprints of publications, and further information are available on request from the Research Centre, Agriculture Canada, University Sub Post Office, London, Ont. N6A 5B7.

H. V. Morley
Director

INTEGRATED PEST MANAGEMENT

Pest management

Integrated control of the onion maggot. Laboratory studies on the onion maggot parasite *Aphaereta pallipes* demonstrated the effect of temperature on development, survival, and effectiveness of this parasite. It was demonstrated that the parasite was most effective between 20–25°C. Although approximately 2 million parasites were produced in the laboratory, a need was demonstrated for developing improved methods of diapause induction and storage. Approximately 1 million onion maggot pupae were reared in mass production field beds that were modified to permit better temperature regulation. Work was also started on studying the physiology of a staphylinid parasitoid, *Aleochara bilineata*, which was confirmed to be a significant parasitoid of the onion maggot under summer conditions. This preliminary work indicated that *A. bilineata* may be more tolerant of drastic fluctuations in temperature and of insecticide treatments. Several new potential predators were identified in 1981 (mostly Staphylinidae), bringing the total to over 70.

Field release of approximately 200 000 *A. pallipes* over 13 wk in the Thedford Marsh confirmed the laboratory observations of poor performance of the parasite during very hot weather, although some parasitism did take

place. Initial results with *A. bilineata* in the field indicated that it was more tolerant than *A. pallipes* to high temperatures. Periods of prolonged, very wet, cold weather interfered with mass release experiments during late summer and fall.

Baseline toxicity data on *A. pallipes* showed that insecticides varied considerably in direct-contact toxicity to the parasite adults. Some striking differences were observed in toxicity to the parasite when the insecticides were incorporated into organic soil. For secondary screening, using formulations applied at recommended field rates, a novel laboratory bioassay technique was developed. The residual effects of eight insecticides, six herbicides, and five fungicides were tested on adults of the onion maggot and its parasite *A. pallipes*. Naled proved to be the insecticide most selective for the parasite. The herbicide chlorporpham proved toxic to both the onion maggot and the parasite. No fungicide tested was toxic either to *A. pallipes* or to the onion maggot at the recommended rates applied.

Monitoring studies. Using pure synthetic sex pheromones, a large number of pheromone dispensers, currently not available commercially, were prepared for use at centers in Ontario and Quebec for monitoring populations of the European corn borer and black cutworm. A cooperative project with the Ontario Ministry of Agriculture and Food to monitor corn borer populations throughout the province and to produce weekly reports on the probability of corn borer problems proved to be extremely valuable. Two commercial preparations of corn borer pheromone were evaluated. One proved to be virtually useless whereas the other worked as well as, or better than, our own preparation. For research purposes and as a service to growers, a monitoring program for the onion maggot was continued at the Thedford Marsh. A trap designed by Dr. Masner of the Biosystematics Research Institute was modified and tested. The trap is simple to assemble and to use, and shows promise for future monitoring studies.

Toxicity–resistance studies. Major emphasis was placed on the problem of house fly resistance to insecticides. A joint project with the University of Guelph showed that selection of a house fly strain with a very low (×1.4) level of resistance to permethrin and organophosphorus insecticides resulted in rapid development of significant levels of resistance when either permethrin or dichlorvos was used as the selection agent. When these two insecticides were used in rotation or combination, the development of resistance was slowed markedly. Results of this laboratory study and subsequent field work at Guelph indicated that development of house fly resistance, under Canadian conditions, can be avoided by rotating the insecticides used. Combination of the insecticides would be even more suitable, but difficulty would be encountered with regard to the necessary registrations.

In order to carry out studies on the genetics of carbofuran resistance in the Colorado potato beetle, carbofuran-resistant strains of the potato beetle were selected over three generations in an effort to obtain a homozygous resistant strain. The level of resistance, previously estimated to be greater than ×1500 is now clearly in excess of ×5000.

Tests conducted on the onion maggot obtained from two locations in Ontario confirmed the presence of low-level multiple resistance to organophosphorus insecticides. Work on the selection of parathion- and carbofuran-resistant onion maggot strains was completed. Parathion resistance was approximately 23-fold after 20 generations of selection, and cross resistance to other recommended organophosphorus and carbamate insecticides also increased significantly. After 12 generations of selection with carbofuran, resistance to that insecticide was approximately ×32.

Evaluation of pesticides. Studies continued on the evaluation of new insecticides for control of agricultural insect pests; 10 experimental insecticides submitted by chemical companies were evaluated in primary screening tests. Most of these were effective contact insecticides with a broad spectrum of activity; two showed some potential as soil insecticides.

Chitin inhibitors such as diflubenzuron and BAY SIR 8154 have been tested and registered for several applications as alternatives to classical insecticides. Both these materials in microplot tests gave promise of effective control of the onion maggot. The granular formulation of BAY SIR 8154 proved to be especially effective, control being only slightly inferior to that provided by chlorfenvinphos. Several pyrethroid insecticides showed promise for the control of the darksided cutworm and tomato hornworm attacking tobacco.

Crop-loss studies. Excellent progress was made on studying losses in potatoes, onions, and rutabagas caused by insects, diseases, and weeds. This appears to be the first reported study on combined losses. With onions, lack of weed control resulted in 100% loss, lack of insect control in 78.1% loss, and lack of disease control in 42.7% loss. With potatoes, lack of weed control gave 20.1% loss, lack of insect control 50.3% loss, and lack of disease control 5.7% loss. In plots with no control at all 62% of the crop was lost. With rutabagas, the major loss resulted from insects, with 59.7% loss, and in plots with no control at all 87.6% of the crop was lost. It is noteworthy that with potatoes the loss resulting from all three factors (62%) was less than the combined total of the three individual factors (76.1%). With rutabagas, on the other hand, the loss resulting from all three factors (87.6%) was higher than the combined total of all three individual factors (59.7%).

Field surveys of field corn in the Hensall area revealed that even when 60% of the plants were infested with egg masses or early larval feeding, negligible damage was found at harvest. A cooperative project with the pesticide industry did not demonstrate an economically significant benefit from spraying with carbofuran.

Analytical studies. Gas chromatography–mass spectrometry studies were carried out to investigate losses encountered during the extraction of carbofuran residues in crops. Two sources of significant loss during sample preparation and assay procedures were identified. The parent compound carbofuran was shown to be progressively degraded (up to 20%) by the 1 h refluxing used to liberate conjugated metabolites. The 3-hydroxycarbofuran metabolite was also shown to be subject to 70% loss, depending upon the procedures used in its extraction.

A method developed previously was found to be suitable for the analyses of three new pyrethroids, deltamethrin, AC 222 705 (Payoff®), and BAY FCR 1272. Residues of these materials on tobacco were determined to be less than 0.01 mg/kg for applications of active ingredient (a.i.) at 10–50 g/ha for control of darksided cutworm and tomato hornworm.

The persistence of aldicarb, aldicarb sulfoxide, aldicarb sulfone, fenvalerate, and isophenphos was studied in mineral and organic soils. Results indicated that aldicarb and its metabolites should pose no environmental problems in soil, although persistence increased with low moisture levels. Isophenphos, however, was relatively persistent, especially in organic soils. Using carrots as an indicator crop, residue levels reached 0.3 mg/kg on mineral soil during the 1st yr but in other crop–soil combinations residues were less than 0.05 mg/kg the 1st yr and all crop residues were less than 0.01 mg/kg for the 2nd yr.

Stored products

There has long been a need for an efficient, sensitive, portable gas chromatograph that could be used for the analysis of fumigants in the field. Recently a Canadian-made instrument has become available for evaluation. The portable gas chromatograph was shown to be extremely efficient for the macro- and microdetermination of phosphine, methyl bromide, ethylene dibromide, formaldehyde, and ethylene oxide to the level of micrograms per kilogram. Field experiments at and elevator bin established that it could be easily used in the field.

The effect of methyl bromide on glutathione levels in susceptible and resistant strains of the granary weevil, *Sitophilus granarius* (L.), was further studied. Analysis of insects after treatment with various quantities of methyl bromide showed that there was a gradual recovery in the level of glutathione in surviving insects. At the end of 7 days the glutathione levels of live insects of both strains had returned approximately to that of untreated, control insects. However, the rate of return to normal levels was faster in the susceptible strain than it was in the resistant strain. Because the level of glutathione in treated, but still living, resistant insects is much lower than in untreated insects and returns to normal only slowly, it is possible that retreatment with similar levels of methyl bromide will produce better control. No change with time was observed in glutathione *S*-transferase activity for insects of either strain following methyl bromide treatment.

Alternative pest control strategies

Plant diseases. A collaborative research project with Harrow Research Station yielded some interesting results and the promise of further developments. Work on the differences in expression of soybean genes, identified with resistance by plant breeders, has been enlarged. All nine major genes identified and their interaction with races 1 to 6 of the

Phytophthora pathogen responsible for bacterial blight were investigated. The effectiveness of the genes was found to be influenced by a number of factors, e.g. light, temparature, and plant injury. However, the overriding factor is the race: the manner in which the gene is expressed and the way this is influenced by other factors depends on the particular gene and race combination. Thus, certain "resistant" combinations may be susceptible under certain conditions that could lead to a breakdown of resistance under field conditions. This work should lead to a better understanding of the mechanism of gene action in resistance and susceptibility and eventually to the development of improved methods of control.

Soybean leaves with symptoms of bacterial blight were obtained from test plots at three sites in southwestern Ontario and one in Manitoba. Twenty-nine bacterial isolates were characterized as *Pseudomonas syringae* pv. *glycinea* on the basis of biochemical and pathogenicity tests. Nine of these isolates were differentiated from previously described races on seven soybean cultivars and hence constitute a new race, race 10. The remaining isolates were virulent on all cultivars, thus conforming to isolates of races 2 and 4, which were not differentiated in the test procedure. Several of the Canadian isolates in this group differed from representative isolates of races 2 and 4 in type and severity of symptoms produced.

It was demonstrated for the first time that macrosporin and its biosynthetic precursor altersolanol A are synthesized by *A. solani* in infected potato tissue. The formation of macrosporin in infected plant tissue is potentially useful as a diagnostic test for early blight infections because it is produced by few other fungi. Altersolanol A, when administered to potatoes, was found to specifically stimulate the accumulation of lubimin but no other stress metabolites of potato. A new *A. solani* metabolite was isolated from culture filtrates and provisionally characterized as 1,1*a*,2,3,4,4*a*-hexahydro-7-methoxy-2-methyl-2,3,5,9-tetrahydro-10-anthrone. This appears to be the first isolation of a compound of this type from nature.

A high-pressure liquid chromatography (HPLC) method was developed for the analysis of the phytotoxin coronatine. Use of the technique established that coronatine was formed in soybean leaves infected with *Pseudomonas glycinea* but not in healthy leaves.

Insect pests. Research in this area is directed toward gaining an understanding of basic life processes peculiar to the insect so that methods of selective, specific control can be developed that do not rely upon pesticides that are broad-spectrum poisons. Work continued on the effect of modification of cell membrane fluidity in relation to the mode of action studies of DDT-type pesticides. Results obtained indicated that the fluidity of the lipid phase of a membrane is a major factor that regulates the extent of DDT interaction with biomembranes. Kelthane, a DDT analogue, was found to be very effective in perturbing the red blood cell membrane. This effect was counteracted by cholesterol. Work on pyrethroids—cypermethrin, permethrin, fenpropionate, and fenvalerate—established that under the conditions studied there was no effect on the transport of K^+ across the mitochondrial and red blood cell membrane. They also had no effect on the respiratory and phosphorylation activity of mitochondria.

Studies were continued that were aimed at establishing whether the proctolin systems could be used as a potential site for the development of new pest control procedures. In vitro experiments showed that several enzymes in the cockroach hemolymph are capable of inactivating proctolin by cleavage of the peptide chain. Contrary to the in vivo study, or to the earlier in vitro work using enzymes from cockroach gut, Arginine–tyrosine was a major product when proctolin was incubated with hemolymph at pH 6.0. Formation of Tyr–Leu–Pro–Thr as the first intermediate in the in vivo degradation of proctolin indicated that an amino peptidase pathway predominates. In the continuing study of the molting process, the presence of an unusual kinase was established in the nematodes. Although this new material is similar to the unique enzyme associated with the molting phase in insects, its characteristics are unlike any other known cyclic nucleotide-dependent protein kinase in either insects or mammals.

Work continued on establishing the basic features of biological transport mechanisms using erythrocytes. Published work contributed to an understanding of transport inhibition by three classes of compounds: substrate analogues, allosteric inhibitors unrelated in structure to the substrate, and chemical reagents acting as irreversible inhibitors. This work provides a sound basis for investigating transport systems in insects,

where there are inherent experimental difficulties such as greater variability between insects and small tissue size.

Systemic fungicides. Soybean seedlings that had been treated with the systemic fungicide metalaxyl produced necrotic lesions characteristic of an incompatible reaction, in spite of the fact that glyceollin accumulated to fungitoxic levels. This and other evidence indicated that glyceollin accumulation is a function of the necrotic process rather than an active defense mechanism. The possibility that fungicide efficacy may be aided by the induction of the host's natural resistance mechanism was investigated at the ultrastructural level. Results showed that in addition to greatly reduced hyphal branching, metalaxyl treatment appeared to damage the membrane system and organelle structure of the fungal hyphae. A thin-layer bioautographic technique was developed, which allowed for the detection of 25 × 10^{-9} g of metalaxyl. The technique was used to measure metalaxyl concentrations in soybean roots, in lower and upper stem tissues, and in the cotyledons at various times after the plants were exposed to various concentrations of fungicide. It was demonstrated that the fungicide accumulated at infected sites at two to five times the concentration applied to the root or to adjoining healthy tissues.

ENVIRONMENTAL TOXICOLOGY

Effects of pesticides on nontarget organisms

The collection of soil arthropods and other soil invertebrates was expanded to over 5000 specimens. During 1981 several specimens of Pauropoda were collected from soil cores. This class of the Myriapoda has not previously been reported in Canada. In addition, a series of staphylinid beetles, collected from the Experimental Farm, have been sent to the Biosystematics Research Institute and will be recorded as the first occurrence in North America. Several new potential predators for biological control of the onion maggot were identified.

Although many studies have been carried out to investigate the effects of pesticides on microbial activities related to soil fertility, the effect of pesticides on soil enzymatic activities has received relatively little attention. Laboratory tests were carried out with 42 pesticides, including insecticides, herbicides, fungicides, fumigants, and a nitrification inhibitor. None of the treatments inhibited activities of invertase and amylase. With the exception of low levels of nitrapyrin, all treatments reduced the adenine triphosphate (ATP) content of organic soils for 1 day, followed by a rapid recovery. In vitro fungitoxicity studies of 26 fungicides and five pyrethroid insecticides on six legume pathogens were carried out using a mycelial-growth inhibition method. At the 5 × 10^{-4} g level most chemicals inhibited growth of *Pythium altimum*, and in many cases significant inhibition was observed with *Fusarium oxysporum* and *Verticillium albo-atrum*. However, some of the pesticides required 10 times the dose level before fungitoxicity was observed. Previous studies have shown that strains of *Rhizobium japonicum* selected for thiram resistance were weak in nitrogen-fixing ability and in invasion and nodulation of soybean roots. Using a different approach, promising results were obtained that demonstrated that plants inoculated with the thiram-resistant cultures had heavier dry material and greater activity in nitrogen fixation than plants inoculated with nonthiram-resistant cultures.

In general, pathogenic, nonpathogenic, and attenuated agrobacteria were found to be considerably more resistant to paraquat than representatives of seven species of *Rhizobium*. Ten strains of bacteria with verified cultural and bacteriophage characteristics were selected for several adaptations to maximum paraquat concentration. The maximum resistance levels achieved by the adoptions varied from 200–20 000 × 10^{-4} g paraquat. With regard to a variety of tests, the adapted bacteria differed little from the parent strains. Thus, no evidence was obtained for any harmful effect of paraquat, even at extreme concentrations, on the symbiotic association with leguminous plants.

Environmental studies

Work on the herbicide nitrofen was completed, involving residues in farm soils, persistence in field microplots, mobility in natural soils, and the role of microbial flora in its degradation. Muck soils from vegetable soils in southwestern Ontario contained up to 35 × 10^{-4} g of nitrofen in August, which had decreased to 18 × 10^{-4} g by October. The

herbicide was less persistent in sandy soils than in muck soils. Leaching from sandy soils was negligible, and it was even more strongly adsorbed by organic soils. Indigenous soil microflora played an important part in the degradation of nitrofen in soils. Research was also completed on the influence of soil microorganisms on the degradation in soil of phorate and its metabolites, carbofuran and its metabolites, and several pyrethroid insecticides.

Studies were completed on the absorption–desorption and the persistence of terbufos and its sulfoxide and sulfone in aqueous soil systems. The mobility of the compounds in soil eluted with water was terbufos sulfoxide $\simeq$ terbufos sulfone $>>$ terbufos, in agreement with adsorption–desorption results. Further refinement of the Freundlich mole fraction concept was achieved, in which the paramount importance of the "correct units" for the Freundlich K value was demonstrated and a simple method to convert it to the mole fraction format was outlined.

Disposal of pesticide containers at the farm level to avoid environmental contamination is a long-standing problem. In 1981 a study of this problem was organized with the cooperation of the Ontario Ministry of the Environment and municipal authorities of the Thedford–Grand Ben Marsh area.

A number of rinsing devices were distributed to selected growers. Residues of pesticides left in the containers after rinsing were determined. Results indicated that in the majority of cases the recommended triple rinse or use of the simple rinsing devices removed most of the residue from the container, rendering it suitable for land-fill site disposal. However, with a few formulations, large quantities of pesticide (pure material at up to 200 g/4.5 L) remained after rinsing in 10 mm-thick cakes at the bottom of the rinsed container. Approximately 3600 containers were collected and disposed of at the test land-fill site during 1981.

Pesticide toxicity and mode of action

A basic requirement of the effective use of pheromones in insect pest management is an understanding of pheromone reception systems in insects. Electroantennogram (EAG) studies on the European corn borer continued, with simultaneous recording of unit receptor response at a local site and the total summed EAG response. Results obtained showed why the antennal tip is more sensitive than the proximal base region, despite the smaller density of sensory hair distribution distally. Results also explained why the response gradient exists only along the antennal axis and not in the perpendicular direction to the axis. A possible core-conductorlike mechanism for EAG summation has been proposed. This pioneer work on the integrating system in the antenna provides fundamental insights into the mechanism of chemoreception.

A breakthrough was made in the study of the mode of action of glyphosate in the inhibition of plant growth. Indoleacetic acid (IAA) is a natural plant growth hormone that alone or in combination with other plant growth regulators controls diverse biochemical responses and growth of plants. Using the tobacco callus culture technique, glyphosate treatment induced significant changes in the metabolism of IAA by increasing its rate of oxidation and promoting the rate of conjugate formation, thereby lowering the level of free IAA. The effect is rapid and accounts for the glyphosate inhibitation of plant growth; the inhibition was reversed by the addition of IAA or 2,4-D.

PUBLICATIONS

Research

Ackrell, B. A.; Ramsay, R. R.; Kearney, E. G.; Singer, T. P.; White, G. A.; Thorn, G. D. 1980. Two small peptides from complex II and their role in the reconstitution of Q reductase activity and in the binding of TTF. *In* B. L. Trumpower, ed. The function of quinones in energy conserving systems. Academic Press, New York, N.Y.

Bowman, B. T. 1981. Anomalies in the log Freundlich equation resulting in deviations in adsorption K values of pesticides and other organic compounds when the system of units is changed. J. Environ. Sci. Health B 16:112-113.

Chapman, R. A.; Harris, C. R. 1981. Persistence of four pyrethroid insecticides in a mineral and an organic soil. J. Environ. Sci. Health B 16(5):605-615.

Chapman, R. A.; Tu, C. M.; Harris, C. R.; Cole, C. 1981. Persistence of five pyrethroid insecticides in sterile and natural, mineral and organic soil. Bull. Environ. Contam. Toxicol. 26:513-519.

Chefurka, W. 1981. ATPase inhibitor and apparent deficiency of uncoupler stimulated ATPase activity in mitochondria of houseflies (*Musca domestica* L.). Comp. Biochem. Physiol. 69B:371-376.

Chefurka, W. 1981. Effects of inhibitors of the respiratory chain and energy-transfer system on mitochondrial ATPase activity of houseflies. Comp. Biochem. Physiol. 69B:361-369.

Chefurka, W. 1981. Metabolism and compartmentation of endogenous fatty acids in aged mouse liver mitochondria. Arch. Biochem. Biophys. 209(2):504-516.

Chefurka, W. 1981. The uncoupler-stimulated adenosine triphosphatase activity in housefly flight-muscle mitochondria. Comp. Biochem. Physiol. 69B:377-385.

Cuppels, D. A.; Van Etten, J. L.; Lambrecht, P.; Vidaver, A. K. 1981. Survey of phytopathogenic pseudomonads for a restriction and modification system active on the double-stranded ribonucleic acid phage ø6. Curr. Microbiol. 5:247-249.

Devés, R.; Krupka, R. M. 1981. Evidence for a two-state mobile carrier mechanism in erythrocyte choline transport: Effects of substrate analogs on inactivation of the carrier by *N*-ethylmaleimide. J. Membr. Biol. 61:21-30.

Devés, R.; Krupka, R. M. 1981. Reaction of internal forms of the choline carrier of erythrocytes with *N*-ethylmaleimide: Evidence for a carrier conformational change on complex formation. J. Membr. Biol. 63:99-103.

Dumas, T.; Bond, E. J. 1981. Method of trapping low levels of phosphine at ambient temperature for GC analysis. J. Chromatogr. 260:384-386.

Hannay, C. L.; McLeod, D. G. R. 1981. A microsporidian infecting the white cutworm, *Euxoa scandens* (Lepidoptera: Noctuidae). Can. Entomol. 113:173-175.

Harris, C. R.; Bowman, B. T. 1981. The relationship of insecticide solubility in water to toxicity in soil. J. Econ. Entomol. 74:210-212.

Harris, C. R.; Chapman, R. A.; Harris, C. 1981. Laboratory studies on the persistence and behaviour in soil of four pyrethroid insecticides. Can. Entomol. 113:685-694.

Harris, C. R.; Svec, H. J. 1981. Colorado potato beetle resistance to carbofuran and several other insecticides in Quebec. J. Econ. Entomol. 74:421-424.

Harris, C. R.; Svec, H. J.; Tolman, J. H.; Tomlin, A. D.; McEwen, F. L. 1981. A rational integration of methods of control of the onion maggot in southwestern Ontario. Proc. Brit. Crop Prot. Conf.—Pests and diseases 3:789-799.

Herne, D. C.; Bond, E. J. 1981. Control of winter eggs of European red mite *Panonychus ulmi* (Koch) on apples by fumigants. Can. Entomol. 113:121-126.

Krupka, R. M.; Devés, R. 1981. An experimental test for cyclic versus linear transport models. J. Biol. Chem. 256(11):5410-5416.

Lazarovits, G.; Stössel, P.; Ward, E. W. B. 1980. Age-related changes in specificity and glyceollin production in the hypocotyl reaction of soybeans to *Phytophthora megasperma* var. *sojae*. Phytopathology 71:94-97.

Lee, T. T.; Starratt, A. N.; Jevnikar, J. J. 1981.. Effect of 3,4-dihydroxyacetophenone and some related phenols on the peroxidase-catalysed oxidation of indole-3-acetic acid. Phytochemistry 20:2097-2100.

McLeod, D. G. R. 1981. Factors affecting the temporal distribution of the spring flight of the European corn borer, *Ostrinia nubilalis*. Can. Entomol. 113:433-439.

McLeod, D. G. R.; Dupre, M. 1981. Laboratory rearing of the white cutworm *Euxoa scandens* (Riley). Ann. Entomol. Soc. Que. 26:95-99.

Miles, J. R. W.; Bowman, B. T.; Harris, C. R. 1981. Adsorption, desorption, soil mobility and aqueous persistence of fensulfothion and its sulfide and sulfone metabolites. J. Environ. Sci. Health B 16(3):309-324.

Miles, J. R. W.; Tu, C. M.; Harris, C. R. 1981. A laboratory study of the persistence of carbofuran and its 3-hydroxy- and 3-keto-metabolites in sterile and natural mineral and organic soils. J. Environ. Sci. Health B 16:409-417.

Miller, D. M. 1981. Pressure-flow characteristics of the roots of *Zea mays*. 2nd Int. Symp. Structure and function of roots. R. Brouwer, et al., eds. Martinus Nijhoff, W. Junk. The Hague. pp. 153-156.

Miller, D. M. 1981. Studies of root function in *Zea mays* II. Dimensions of the root system. Can. J. Bot. 59:811-818.

Nagai, T. 1981. Electroantennogram response gradient on the European corn borer antenna. J. Insect Physiol. 27(12):889-894.

Ramsay, R. R.; Ackrell, B. A. C.; Coles, C. J.; Singer, T. P.; White, G. A.; Thorn, G. D. 1981. Reaction site of carboxanilides and of thenoyltrifluoroacetone in complex II. Proc. Natl. Acad. Sci. 78(2):825-828.

RESEARCH CENTRE, LONDON, ONT.

Roslycky, E. B. 1981. Influence of terbacil on microbiota in soil and cultures. Can. J. Soil. Sci. 61:11-17.

Sharom, M. S.; Miles, J. R. W.; Harris, C. R.; McEwen, F. L. 1981. Organochlorine and organophosphorus insecticide residue in the organic soil and drainage system of an agricultural watershed planted with vegetables. MARDI Res. Bull. 8(1):61-73.

Starratt, A. N.; Bodnaryk, R. P. 1981. Stereoisomeric identity of octopamine in the central nervous system of invertebrates. Insect Biochem. 11(6):645-648.

Starratt, A. N.; Bond, E. J. 1981. Metabolism of methyl bromide by susceptible and resistant strains of the granary weevil, *Sitophilus granarius* (L.). Pestic. Biochem. Physiol. 15:275-281.

Stoessl, A. 1981. Structure and biogenetic relations: Fungal non host-specific. Pages 110–219 *in* R. D. Durbin, ed. Toxins in plant disease. Academic Press, New York, N.Y.

Stoessl, A.; Rock, G. L.; Gayed, S. K. 1981. Virtual absence of capsidiol and related stress compounds from field-grown tobacco naturally infected with *Peronospora tabacina*. J. Plant Dis. Prot. 88(6):367-372.

Stoessl, A.; Stothers, J. B. 1981. A carbon-13 biosynthetic study of stress metabolites from potatoes: The origin of isolubimin. Can. J. Bot. 59:637-639.

Stössel, P.; Lazarovits, G.; Ward, E. W. B. 1980. Penetration and growth of compatible and incompatible races of *Phytophthora megasperma* var. *sojae* in soybean hypocotyl tissues differing in age. Can. J. Bot. 58(24):2594-2601.

Stössel, P.; Lazarovits, G.; Ward, E. W. B. 1981. Cytochemical staining and in vitro activity of acid trimetaphosphatase in etiolated soybean hypocotyls. Can. J. Bot. 59:1501-1508.

Stössel, P.; Lazarovits, G.; Ward, E. W. B. 1981. Differences in the mode of penetration of soybean hypocotyls by two races of *Phytophthora megasperma* var. *sojae*. Can. J. Bot. 59:1117-1119.

Stössel, P.; Lazarovits, G.; Ward, E. W. B. 1981. Electron microscope study of race-specific and age-related resistant and susceptible reactions of soybeans of *Phytophthora megasperma* var. *sojae*. Phytopathology 78:617-623.

Stillman, M. J.; Stothers, J. B.; Stoessl, A. 1981. Capsidiol and *1*-epicapsidiol: Absolute configuration, NMR, and optical spectra of the dibenzoates. Can. J. Chem. 59:2303-2305.

Tomlin, A. D. 1981. Effects on soil fauna of the fungicide benomyl, used to control earthworm populations around an airport. Prot. Ecol. 2:325-330.

Tomlin, A. D.; Tolman, J. H.; Thorn, G. D. 1981. Suppression of earthworm (*Lumbricus terrestris*) populations around an airport by soil application of the fungicide, benomyl. Prot. Ecol. 2:319-323.

Tu, C. M. 1981. Effect of fungicidal seed treatments of alfalfa growth and nodulation by *Rhizobium melilotti*. Chemosphere 10:127-134.

Tu, C. M. 1981. Effects of pesticides on activities of enzymes and microorganisms in a clay soil. J. Environ. Sci. Health B 16(2):179-191.

Tu, C. M. 1981. Effects of some pesticides on enzyme activities in an organic soil. Bull. Environ. Contam. Toxicol. 27:109-114.

Tu, C. M. 1981. Influence of pesticide seed treatments of *R. japonicum* and symbiotically grown soybeans in soil under laboratory conditions. Prot. Ecol. 3:41-46.

Van Etten, J. L.; Meints, R. H.; Burbank, D. E.; Kuczmarski, D.; Cuppels, D. A.; Lane, L. C. 1981. Isolation and charaterization of a virus from the intracellular green alga symbiotic and *Hydra viridis*. Virology 113:704-711.

Vardanis, A.; Finkelman, M. 1981. A radiometric microassay for cellulase activity. Anal. Biochem. 115:78-80.

Ward, E. W. B.; Stössel, P.; Lazarovits, G. 1981. Similarities between age-related and race specific resistance of soybean hypocotyl to *Phytophthora megasperma* var. *sojae*. Phytopathology 71:504-508.

Miscellaneous

Foott, W. H.; McLeod, D. G. R. 1981. European corn borer. Ont. Min. Agric. Food Factsheet. Agdex 111.632.

Gnanamanickam, S. S.; Ward, E. W. B. 1981. *Pseudomonas glycinea* on soybeans: A new race of the pathogen and variations in systemic symptoms. Can. J. Plant Pathol. 3:114.

Lazarovits, G.; Stössel, P.; Ward, E. W. B. 1980. Hypersensitivity and glyceollin production in soybeans treated with Ridomil to control phytophthora rot. Phytopathology 71:258.

Lazarovits, G.; Stössel, P.; Ward, E. W. B. 1980. Specificity and glyceollin production in the hypocotyl reaction of soybeans to *Phytophthora megasperma* var. *sojae*. *In* R. K. W. Wood, ed. Active defence mechanism in plants. Nato Advanced Study Institute.

Lazarovits, G.; Ward, E. W. B. 1981. Uptake and translocation of Ridomil in healthy and *Phytophthora megasperma* f. sp. *glycinea* infected soybean seedlings. Can. J. Plant Pathol. 3:116.

Miles, J. R. W. 1980. Adsorption of insecticide residues—Importance of environmental sampling and analysis. *In* B. K. Afghan and D. Mackay, eds. Hydrocarbons and chlorinated hydrocarbons in the aquatic environment. Vol. 16 Environmental Science Research. Plenum Press, New York and London. 588 pp.

Starratt, A. N. 1981. Book review: Structure and activity of natural peptides—Selected topics. J. Pestic. Biochem. Physiol. 634 pp.

Starratt, A. N.; Stoessl, A.; Cuppels, D. A.; Spencer, E. Y. 1981. *In* R. Wegler, ed. Chemie der Pflanzenschutz—und Schadlingsberkampfungsmittel, Vol. 6. Springer-Verlag, Berling, Heidelberg, New York. 512 pp.

Stössel, P.; Lazarovits, G.; Ward, E. W. B. 1979. Soybean—*Phytophthora megasperma* var. *sojae* interactions. II. Phosphatase and phosphadiesterase in infected hypocotyls. Proc. Can. Phytopathol. Soc. 46.

Stössel, P.; Lazarovits, G.; Ward, E. W. B. 1980. Growth of races of *Phytophthora megasperma* var. *sojae* in soybean hypocotyl tissue. Phytopathology 71:258.

Tomlin, A. D. Earthworms. Canadex (Livestock) 489:1-4.

Ward, E. W. B. 1979. Metabolism of the phytoalexin capsidiol to 13-OH capsidiol in pepper fruits. Proc. Can. Phytopathol. Soc. 46.

Ward, E. W. B.; Lazarovits, G. 1981. Influence of temperature on the disease reaction of soybean hypocotyls inoculated with *Phytophthora megasperma* var. *sojae*. Phytopathology 71:911.

Ward, E. W. B.; Stössel, P.; Lazarovits, G. 1980. Effect of tissue age, heat and other treatments on specificity and glyceollin production in the hypocotyl reaction of soybeans to *Phytophthora megasperma* var. *sojae*. Phytopathology 71:263.

Research Station
Delhi, Ontario

PROFESSIONAL STAFF

P. W. Johnson, B.S.A., M.Sc., Ph.D.	Director
E. G. Ashby	Administrative Officer

Tobacco

H. H. Cheng, B.Sc., M.Sc., Ph.D.	Entomology
W. A. Court, B.Sc., M.Sc., Ph.D.	Chemistry
J. M. Elliot, B.S.A., M.S.A.	Soil science
S. K. Gayed, B.Sc., M.Sc., Ph.D.	Plant pathology
R. S. Pandeya, B.Sc., M.Sc., Ph.D.	Genetics and plant breeding
N. Rosa, B.Sc., M.Sc., Ph.D.	Plant physiology
E. K. Walker, B.S.A., M.S.	Plant science
B. F. Zilkey, B.S.A., M.Sc., Ph.D.	Plant physiology

New Crops

R. C. Roy, B.Sc. (Agr.), M.Sc.	Agronomy

Departure

F. H. White, B.Sc., M.Sc. Retired 29 December 1981	Genetics and plant breeding

EXTENSION SERVICES[1]

M. C. Watson, B.S.A.	Tobacco
N. W. Sheidow, B.Sc.	Tobacco

DELHI ENGINEERING RESEARCH GROUP[1]

D. A. STIER, B.Sc. Engineer

[1]Provided by the Ontario Ministry of Agriculture and Food.
[2]Provided by the Ontario Flue-Cured Tobacco Growers' Marketing Board and the Canadian Tobacco Manufacturers' Council.

INTRODUCTION

The Research Station at Delhi is the primary center for research on flue-cured tobacco in Canada. Multidisciplinary research is directed toward simultaneous increases in production efficiency, improvement of chemical and physical quality, better usability of flue-cured tobacco, and reduction of the biological activity of smoke by the alteration of crop production practices, varieties, harvesting methods, and curing. The development of pest control programs to minimize pesticide residues forms a significant part of the research program, as does an engineering program concerned with the reduction of energy use in tobacco production and the reduction of labor through mechanization. The engineering program is funded jointly by the Ontario Flue-Cured Tobacco Growers' Marketing Board and the Canadian Tobacco Manufacturers' Council and is administered through the Research Station. In 1981 a new crops program was initiated to complement our tobacco research and make more effective and economic use of land in rotation or alternate crops.

This report includes brief summaries of some of the research completed in 1981. More detailed information may be obtained from the publications listed or by contacting individual scientists at the Research Station, Research Branch, Agriculture Canada, P.O. Box 186, Delhi, Ont. N4B 2W9.

P. W. Johnson
Director

TOBACCO PRODUCTION

Seedling culture

Although bending-force measurements on seedling stems showed some relationship to seedling hardiness and to the ability of seedlings to survive well and flower early in the field, the ratios of stem length to stem diameter and shoot weight to root weight were more meaningful in these respects.

Equipment was developed to automate filling of Todd cell trays with peat-based type media and seeding of trays with pelleted seed. With this equipment about 60 trays (12 000 cells) per hour were prepared by one person.

Topping

Six varieties (Delgold, Delhi 76, Newdel, Nordel, Virginia 115, and CD15) were grown at two levels of applied nitrogen (N), 33.6 kg/ha and 50.4 kg/ha, and were topped at 13, 16, and 19 leaves. Yield increased with increased topping height for all varieties at both N levels. The size of the tips of leaves declined with each three-leaf increase in topping height for both N levels. The higher yield with increasing topping height resulted from the greater number of leaves. Generally, total alkaloids and price tended to decrease with increased topping height. The higher nitrogen level resulted in higher yields of tobacco with higher alkaloids at each topping height.

Curing

Use of the styrofoam SM under concrete pads of bulk kilns or around the exterior pad edges reduced heat transfer from the kiln. Consideration of heat transfer coefficients and material cost revealed a payback period of 8.3 and 14.6 cures for 2.5 and 5.0 cm of insulation under the pad, respectively, and 2 cures for 5.0 cm of edge insulation only.

Consumption of natural gas for curing was considerably reduced in a conventional kiln by coating the exterior surface, above the foundation, with 1.25 cm of polyurethane foam. Compared with an identical kiln, where only the cracks were sealed with the foam, a saving of about 20% was realized. At current fuel and material costs, the payback period for such a retrofit was 21 cures.

Introduction of ethylene gas for the first 24 h of curing at levels of 24–48 mg/kg reduced yellowing time by 6–12 h and somewhat darkened the base color. Characteristically, treated leaves that were orange to deep orange after curing, compared with lemon to orange for nontreated leaves, had higher ratings of market acceptability from commercial buyers.

GENETICS AND PLANT BREEDING

New flue-cured tobacco cultivar released

In 1981 Newdel was licensed for commercial production in Canada. The original genetic code for this cultivar, 76N3-B, evolved from an interspecific hybridization study using *Nicotiana tabacum* L. and *N. rustica* L. Newdel's pedigree is [Delhi 34 ⌊(NRT × Delhi 34)⌋ Delhi 34] Virginia 115.

Newdel is superior to Virginia 115 in yield, grade, and returns per hectare. Early uniform maturity results in a cured-leaf quality of superior grade compared with Virginia 115. Agronomic, chemical, physical, and smoke characteristics are better than Virginia 115. Although a notable increase in the leaf nicotine content was achieved in Newdel, smoke tar was not affected. Consequently, tar-to-nicotine ratio declined for Newdel, a significant achievement from a tobacco and health standpoint. In 1981 about two-thirds of our hectarage was planted to Delgold, Nordel, and Delhi 76 (Delgold was planted on over 60% of the tobacco hectarage), which has improved the nicotine content of Canadian tobacco. Higher nicotine and lower tar-to-nicotine ratio of the cultivar Newdel will further improve the quality of Canadian tobacco for domestic and export markets.

Mutagenesis

Two isogenic lines of 73M-26 (A and B) were developed by gamma radiation of Delhi 34 seed and were shown to have double the leaf nicotine content of the parent, 6% versus 2.8–3% nicotine, and a tar-to-nicotine ratio of 4–5 as opposed to 11–12. These mutant lines yield 350–400 kg/ha less than Delhi 34, but the total nicotine production is substantially higher. Strains A and B of 73M26 are expected to serve as a very useful source of germ plasm in breeding studies to further lower tar-to-nicotine ratios.

CHEMISTRY

Chemical composition of selected tobacco cultivars with various weather fleck tolerances

A 3-yr experiment was conducted to examine the chemical composition of selected flue-cured tobacco cultivars with a range of weather fleck tolerances. The amount of surface wax was found to be significantly related to the weather fleck tolerance of the cultivar; however, individual phenolic constituents, nonvolatile organic acids, and fatty acids were not related to weather fleck in the cultivars used in the study.

Influence of applied nitrogen on certain lipid constituents of flue-cured tobacco

A comparison was made of three rates of N fertilization (17.8, 33.6, and 44.8 kg/ha) on the levels of certain lipid constituents. Increases in N increased the concentration of neoxanthin, violaxanthin, lutein, carotene, chlorophyll *a*, and chlorophyll *b*. Some variation was apparent with the terpenes examined and N fertilization. Neophytadiene increased, the duvatrienediols decreased, and solanesol did not vary greatly with N fertilization. The cytoplasmic lipids and hexane extractables increased with N fertilization, but the reverse was true for the amount of surface wax.

Carbohydrates

The 80% ethanol-soluble fraction of tobacco lamina contained a significant proportion of low molecular weight saccharides (44%). Twelve constituents were studied extensively after isolation, characterization, and quantification by gas chromatography (GC). The simple sugars fructose, glucose, inositol, and sucrose were the major constituents. Other constituents included xylose, ribose, psicose, sorbitol, maltose, gentiobiose, erlose, and glucopyranosylvyoinositol. The components, quantitated by GC, accounted for 98.9% of the saccharide constituents in the ethanol extract. This study was concluded during a 6-mo work transfer to the Food Research Institute, Ottawa.

Tobacco and tobacco smoke chemistry

A set of 25 test cigarettes were manufactured from various treatments, including cast tobacco sheeting of bright and burley tobacco grown in Ontario, and a tobacco substitute, Cytrel®.

Tobacco sheeting tended to reduce filling value, total alkaloids, reducing sugars, total and protein N, and ash, and to increase fiber, cellulose, and lignin. In cigarette smoke, sheeting tended to decrease nicotine, nitromethane extractables, phenols, cresols, neophytadiene, acetaldehyde, acrolein, and total aldehydes, but increased carbon monoxide

and total hydrogen cyanide deliveries. Generally, the data indicated that levels of compounds that may be considered toxic in cigarette smoke may be reduced by the modified Process Chopped Leaf (PCL) cast sheeting method using blends containing dense-population, chopped, bright whole plant tobacco sheet, or Cytrel® and by high-efficiency cellulose acetate filters.

TOBACCO PROTECTION

Entomology

Cutworms. During subsequent studies on the parasites of the dark-sided cutworm, *Euxoa messoria* (Harris), at Delhi, Ont., four more species of primary endoparasites were newly recorded, namely, *Apanteles laeviceps* Ashmead (Braconidae), *Apanteles militaris* Walsh (Braconidae), *Campoletis* sp. (Ichneumonidae), and *Meteorus communis* (Cresson) (Braconidae). *Arenetra* sp. reported in the earlier work appeared again and was determined to be *A. rufipes vernalis* Walley (Ichneumonidae).

For cutworm control, eight insecticides were evaluated in six experiments in the greenhouse and field. In comparison with the standard treatments of cypermethrin, a superior to similar degree of cutworm control was obtained with three new pyrethroids, deltamethrin, Pay-off, and Bay FCR 1272. Deltamethrin is the most powerful insecticide tested this year; it was about five times more toxic against cutworms than cypermethrin. The remaining insecticides provided inadequate cutworm control. None of the insecticides tested caused visible phytotoxicity to the tobacco plants.

Aphids. A 3-yr study confirmed that winged green peach aphids always appeared and established their colonies on tobacco plants before they were detected in water traps. There is no correlation between the aphid population on plants in tobacco fields and catches in the water traps.

Plant pathology

During the winter and spring, a survey for the resting stage of *P. tabacina* was carried out in certain fields that were infected during the 1979 epidemic. No oospores could be detected, and bioassays using soil suspensions to infect tobacco seedlings with blue mold were negative, denoting the dormancy or absence of oospores.

Metalaxyl field sprays with active ingredient (a.i.) at 1.25 kg/ha recommended in 1980, and double this rate, had no effect on yield and on quality of tobacco and smoke, and residues of metalaxyl were within the acceptable range.

Trials in 1981 were mainly concentrated on mixtures of mancozeb and metalaxyl at ratios of 8:1 or 6:1. Two rates from each mixture were tried, the lower in four sprays 2 wk apart and the higher in eight sprays once a week starting June 11. The treatments had no effect on yield or on quality of tobacco and smoke. Residues of metalaxyl were within the acceptable range, but those of mancozeb were high in the first primings but much lower in the tips. Residues based on a weighted average of the five primings were, however, within the acceptable range.

Weed control

Three herbicide treatments exhibited excellent control of both annual grass and broad-leaved weeds and very high agronomic performance: diphenamid applied post-transplant, at 6.75 kg/ha in a 25-cm band over the row; pebulate applied pretransplant, incorporated at 6.0 kg/ha, combined with napropamide applied post-transplant, at 1.0 kg/ha in a 25-cm band over the row; and napropamide alone applied post-transplant, at 1.0 kg/ha in a 25-cm band over the row.

NEW CROPS

Preliminary research was started on production practices of colored beans (e.g. kidneys, blacks, pintos), mung beans, spring and winter canola, chick-peas, sunflowers, and sorghum.

Peanuts

Peanut research this year led to the pending registration of metolachlor for weed control and fenvalerate for insect control. The once-over harvesting technique continued to perform well and has led to commercial production of peanut harvesters in Ontario.

PUBLICATIONS

Research

Ablett, G. R.; Roy, R. C.; Tanner, J. W. 1981. Agronomic aspects of normal and abnormal root formations in peanuts (*Arachis hypogaea* L.). Peanut Sci. 8(1):25-31.

Cheng, H. H. 1981. Additional hymenopterous parasites newly recorded from the darksided cutworm, *Euxoa messoria* (Lepidoptera: Noctuidae) in Ontario. Can. Entomol. 113:773-774.

Cheng, H. H. 1981. Effects of tank-mixed combinations of insecticides and sucker control agents on efficacy and on the yield and quality of flue-cured tobacco. Proc. Entomol. Soc. Ont. 111:7-12 (1980).

Gayed, S. K.; Rosa, N. 1980. Laboratory studies on the production of carbon dioxide and ethylene by tobacco leaf tissue healthy or infected with *Rhizopus arrhizus*. Tob. Sci. 24:150-153.

Hergert, G. B.; Walker, E. K. 1981. Equipment for whole-plant harvest of flue-cured tobacco. Can. Agric. Eng. 23:5-9.

Johnson, P. W. 1981. Observations on the cuticle ultrastructure of *Meloidogyne hapla* males. J. Nematol. 13:231-233.

Pandeya, R. S.; Rosa, N.; Dirks, V. A. 1981. Relationship between green and cured leaf total alkaloids of topped and untopped plants in relative ranking of flue-cured tobacco genotypes (*Nicotiana tabacum* L.). Tob. Sci. 25:42-47.

Pandeya, R. S.; White, F. H. 1981. Nordel, a new bright tobacco cultivar. Can. J. Plant Sci. 61:795-797.

Reddy, V. M.; Tanner, J. W.; Roy, R. C.; Elliot, J. M. 1981. The effects of irrigation, inoculants and fertilizer nitrogen on peanuts (*Arachis hypogaea* L.). II. Yield. Peanut Sci. 8(2):125-128.

Siddiqui, I. R.; Rosa, N.; Benzing, L. 1981. An amadori compound from tobacco. Carbohydr. Res. 98:57-63.

Sirons, G. J.; Zilkey, B. F.; Frank, R.; Paik, N. J. 1981. Residues of diphenamid and its phytotoxic metabolite in flue-cured tobacco. J. Agric. Food Chem. 29(3):661-664.

Stoessl, A.; Rock, G. L.; Gayed, S. K. 1981. Virtual absence of capsidiol and related stress compounds from field-grown tobacco naturally infected with *Peronospora tabacina*. Z. Pfl. Krankh. Pfl. Schutz. 88(6):367-372.

Walker, E. K. 1981. Culture of flue-cured tobacco seedlings in Todd cells: Influence of size of cell, age of seedling and time of field transplanting. Tob. Sci. 25:97-101.

Walker E. K.; Fagan, W. E. 1981. An improved lamina sampler for cured tobacco. Tob. Sci. 25:13-14.

White, F. H.; Pandeya, R. S. 1981. Delhi 76 bright tobacco. Can. J. Plant Sci. 61:791-793.

Miscellaneous

Cheng, H. H. 1980. Occurrences of major pests on tobacco and peanuts in Ontario. Can. Agric. Insect Pest Rev. 58:21-22, 43.

Cheng, H. H. 1981. Progress in integrated pest management of tobacco insects in Canada. The Lighter 51(3):17-21.

Elliot, J. M. 1981. A survey of flue-cured tobacco grown in Ontario in 1980. Part I: Sugars, alkaloids, nitrogen, chlorine and lamina weight. The Lighter 51(2):12-14.

Gayed, S. K. 1980. Blue mold of tobacco—Past and present. The Lighter 50(1):5-10.

Johnson, P. W. 1981. Soil fumigants. Ont. Min. Agric. Food. Agdex 606.

Johnson, P. W.; Potter, J. W. 1981. Nematode control—Guidelines for the application of soil fumigants. Ont. Min. Agric. Food. Agdex 628.

Johnson, P. W.; Potter, J. W. 1981. Soil and root sampling for nematode analysis. Ont. Min. of Agric. Food Agdex 628.

Pandeya, R. S.; White, F. H. 1981. Delgold—A new flue-cured tobacco cultivar. The Lighter 51(2):23-26.

Reynolds, L. B.; Walker, E. K. 1981. Tobacco irrigation with travelling gun sprinklers. Ont. Min. Agric. Food. Agdex 181/565.

Rosa, N.; Caughill, C. W. H. 1981. The effect of frost on agronomic and quality characteristics of flue-cured tobacco. The Lighter 51(2):27-29.

Rosa, N.; Pandeya, R. S. 1981. Estimation of tobacco chemical constituents by infrared reflectance spectroscopy. The Lighter 51(1):17-21.

Walker, E. K.; Stier, D. A. 1981. Engineering studies on flue-cured tobacco, 1980–81. Delhi Eng. Res. Group and Delhi Res. Stn. Rep. No. 4.

White, F. H.; Pandeya, R. S. 1981. Relative performance of new flue-cured tobacco varieties. The Lighter 51(2):18-22.

Zilkey, B. F. 1981. The effect of herbicides on flue-cured tobacco in Ontario, 1979. The Lighter 51(3):14-16.

Research Station
Harrow, Ontario

PROFESSIONAL STAFF

C. F. Marks, B.Sc. (Agr.), M.S.A., Ph.D.	Director
D. H. Lee	Administrative Officer
E. Champagne,[1] M.A., M.L.S.	Librarian

Crop Science

R. I. Buzzell, B.S., Ph.D.	Head of Section; Soybean breeding
D. Bagnara, Dr.Sc.Agr., Ph.D.	Corn breeding
B. R. Buttery, B.Sc., Ph.D.	Soybean physiology
V. A. Dirks, B.S.A., M.Sc., Ph.D.	Statistics
S. J. Park, B.S., M.S., Ph.D.	Field bean breeding
A. H. Teich, B.A., M.S.A., M.Sc., Ph.D.	Winter wheat breeding
T. W. Welacky, B.Sc., B.Sc. (Agr.)	Burley tobacco

Entomology

W. H. Foott, B.S.A., M.S.A., Ph.D.	Head of Section; Field crop insects
W. M. Elliott, B.Sc., Ph.D., D.I.C.	Vegetable and fruit insects
R. P. Jaques, B.S.A., M.S.A., Ph.D.	Insect pathology
R. J. McClanahan, B.A., M.Sc., Ph.D.	Greenhouse and field vegetable insects
B. C. Smith, B.A.	Field crop insects

Horticultural and Soil Science

W. I. Findlay, B.Sc., M.Sc., Ph.D.	Head of Section; Soil fertility
T. J. Jewett, B.Sc.	Greenhouse energy engineer
R. E. C. Layne, B.Sc., M.S., Ph.D.	Tree fruit breeding
A. Liptay,[2] B.S.A., M.Sc., Ph.D.	Vegetable management
A. P. Papadopoulos, M.Sc. (Agr.), M.Sc. (Hort.)	Greenhouse management
C. S. Tan, B.Sc., M.Sc., Ph.D.	Soil moisture and agrometeorology

Plant Pathology

W. R. Jarvis, B.Sc., Ph.D., D.I.C.	Head of Section; Vegetable diseases
T. R. Anderson, B.S.A., M.Sc., Ph.D.	Soybean diseases
W. G. Bonn, B.Sc., M.S., Ph.D.	Bacterial diseases of fruit and vegetables
B. N. Dhanvantari, B.Sc., M.Sc., Ph.D.	Bacterial diseases of vegetables
L. F. Gates, B.A., Ph.D.	Cereal and corn diseases
J. A. Traquair, B.Sc., Ph.D.	Tree fruit diseases
J. C. Tu, B.Sc., M.Sc., Ph.D.	White bean diseases

Weed Science and Chemistry

P. B. Marriage, B.Sc., Ph.D.	Head of Section; Weed physiology
J. D. Gaynor, B.Sc., M.Sc., Ph.D.	Environmental chemistry
A. S. Hamill, B.Sc., M.Sc., Ph.D.	Weed science
D. R. Phillips, B.Sc., M.Sc., Ph.D.	Weed physiology
S. E. Weaver, B.A., Ph.D.	Weed ecology

Departures

E. F. Bolton, B.S.A., M.S.A., Ph.D. Died 8 October 1981	Soil management
H. A. Quamme, B.S.A., M.Sc., Ph.D. Transferred; Research Station, Summerland, B.C., 1 August 1981	Tree fruit breeding

VISITING SCIENTIST

I. Ben Ze'ev, Ph.D. Natural Sciences and Engineering Research Council	Insect pathology

EXTENSION SERVICES[3]

J. C. FISHER, B.S.A. — Greenhouse and fresh market vegetables

L. A. HUFFMAN, B.Sc. (Agr.) — Fruit crops and asparagus

---

[1]Seconded from Libraries Division, Finance and Administration Branch.
[2]On a transfer of work, the Institut f. Gemusebau, Germany, from August 1980 to August 1981.
[3]Provided by Ontario Ministry of Agriculture and Food.

INTRODUCTION

The Research Station at Harrow serves southwestern Ontario, where favorable climatic conditions permit intensive and diversified agriculture. Research programs are designed to improve yield, quality, and efficiency of crop production to contribute to the economic, environmental, and social needs of the area. Crops under study include field and greenhouse vegetables, tree fruits, corn, soybeans, white beans, winter wheat, and burley tobacco. Crop improvements are achieved by the breeding of new varieties with superior characteristics and the development of improved crop, pest, and soil management practices.

The staff was saddened by the sudden death of one of our soil scientists, Dr. E. F. Bolton, who had contributed greatly to the development of systems for the effective utilization and management of Brookston clay soils.

The report provides brief summaries of results obtained in 1981. Further information can be obtained by writing to the Research Station, Research Branch, Agriculture Canada, Harrow, Ont. N0R 1G0.

C. F. Marks
Director

FIELD CROPS

Corn

Breeding. A new inbred line, CH 753-4, was released. It is characterized by early flowering, good tolerance to first-generation corn borer, excellent standing, and good combining ability for yield compared with other inbred lines in domestic tests and in U.S. north central regional uniform tests.

Crop and soil management. Analysis of 10 yr of data from Brookston clay indicated that drainage, rotation, and fertilizer generally increased corn yields. Yield of corn increased by 0.45 t/ha with each 2-m reduction in distance from the subsurface drain. Rotation was essential for maintaining soil tilth, and alfalfa contributed more nitrogen (N) than did commercial fertilizers. Highest yields of corn were obtained with close spacing between drains, with fertilizer, and in rotation following alfalfa.

Denitrification in Brookston clay. In collaboration with Dr. D. J. McKenney, University of Windsor, nitric oxide (NO), nitrous oxide, and nitrite ion production was measured in Brookston clay columns undergoing anaerobic denitrification. A flow-system was used whereby argon gas continuously stripped soil gases from the column, allowing steady-state rates to be obtained. Over several days, the temporal change in rates of these gases and NO_2^--N followed a pattern of increase and decay, which may be expected of a reaction proceeding by several consecutive steps. The method permitted observation of the relatively large net production rate of NO, which is normally not observed in static systems used for capturing gaseous denitrification products. With the onset of anoxic conditions, the net rate of NO production increased sharply, paralleling a rapid increase in NO_2^- level. A similar, though less pronounced, pattern was observed for N_2O with net rates of production less than for NO. Estimated N_2 production appeared to be initially high, decreased rapidly, and then gradually increased with time following the establishment of anaerobic conditions.

Diseases. Small numbers of virus-infected plants were found in field and sweet corn in June, and substantial infection of later-planted sweet corn was found in July and August. All except three of the virus isolates collected have been transmitted by *Myzus persicae.* Particle lengths for virus isolates from various fields ranged between 729 and 771 nm. It seems likely that many or all of the isolates are of the maize dwarf mosaic virus.

Insects. European corn borer investigations on Brookston clay soil at the Woodslee Soil Substation showed that the pattern of oviposition was similar to that observed previously on sandy loam soils at Harrow. Small numbers of egg masses were laid by the first generation and much larger numbers of eggs were laid by the second generation, with considerably more found in a late planting than in an early one.

Yields were determined for four different combinations of planting and harvesting dates: early planting, early harvest; early planting, late harvest; late planting, early harvest; and late planting, late harvest. Plots treated to control both generations or only the second generation had significantly higher yields than untreated plots in every instance. There were no significant differences between untreated plots and those treated just to control the first generation.

As a step in the development of an adult–yield relationship for predicting losses in the year following adult monitoring, a method was developed to estimate, with the use of sticky traps, yield of grain corn in terms of numbers of adults of western corn rootworm, *Diabrotica virgifera* LeConte, that emerged in the previous August. Numbers of adults per trap plant on 28 July were closely related ($R^2 = 0.9550$) to yield as dry weight of grain at harvest. Slopes of regression lines of adult–yield relationships for the 12-day interval from 28 July to 9 August did not differ significantly. Percentage yield loss associated with the production of one adult per trap plant was 1.18, which is close to the 1.16% loss per adult based on emergence from artificial western corn rootworm infestations in cages in the United States corn belt. The break-even level, or threshold, of western adults for cost-efficient use of larvicides was 2.61 (2.0–3.3) adults per trap plant per day based on cost of larvicide at $25/ha, yield at 6.28 t/ha, and price of corn at $118/ha. Eighty-five percent of grain farms and 20% of seed corn farms surveyed in 1981 had adult-population levels above threshold.

Weed control. Where cultivation was combined with herbicide use, reducing the amount of selected herbicides from the recommended rate lowered the weed control rating only slightly, providing cultivation was used. Without cultivation, velvetleaf was not adequately controlled. Banding the herbicide and cultivating gave weed control equal to spraying. Banding the herbicide without cultivation gave poorer weed control than did cultivation alone.

Weed ecology and physiology. Populations of redroot pigweed and green pigweed resistant or susceptible to atrazine differed in competitive ability in greenhouse trials. In both species, the susceptible population had a greater competitive ability with respect to biomass and seed production than did the resistant population. These differences may explain why resistant plants are uncommon in the absence of atrazine. The susceptible population of green pigweed was more competitive than either the susceptible or resistant populations of redroot pigweed. The resistant population of green pigweed was more competitive than the resistant population of redroot pigweed but was equally competitive to the susceptible population of redroot pigweed.

Soybeans

Diclofop-methyl persistence. Diclofop-methyl and diclofop were extracted from soil with an acidic organic extract, and the products were separated by hexane partition. The ester fraction was hydrolyzed and the acid alkylated with pentafluorobenzyl bromide before gas chromatography and detection by electron capture. The detector was six to eight times more sensitive to the pentafluorobenzyl derivative than to the methyl ester, thus permitting detection of diclofop at 0.05 mg/kg in soil with little interference by coextractives.

Diclofop-methyl underwent rapid hydrolysis to diclofop in soil but less ester was hydrolyzed at pH 5.5 than at pH 7.5 after 24 h. The slower rate of hydrolysis increased the half-life from 22 days at pH 7.5 to 30 days at pH 5.5. Diclofop degraded in soil according to first-order kinetics and had a half-life of 13 days in Fox sandy loam and 19 days in Brookston clay loam in 1980. Under the cooler conditions that occurred in 1981, diclofop had a half-life of 31 days in Fox soil and 39 days in Brookston soil.

Herbicides and nodulation. Reduced nodulation of soybean plants was observed when seeded in preplant-incorporated treatments of the dinitroaniline herbicides trifluralin, ethalfluralin, or dinitramine, each in combination with metribuzin. The effect was not observed in all years with all herbicides. Ethalfluralin had the greatest effect on nodulation, followed by dinitramine. Trifluralin and ethalfluralin treatments caused only slight decreases in shoot and root weight at the flowering stage, and soybean yields were not affected. However, where dinitramine caused stunting and reductions in shoot and root weight, yield was decreased. The decreasing order of persistence of the dinitroaniline herbicides based on their calculated half-life was found to be trifluralin (128 days), ethalfluralin (61 days),

and dinitramine (50 days). The profile distribution of the chemicals indicated that over 88% of the herbicide was retained in the top 7.5 cm of soil. Dinitramine, which has a higher water solubility, was more uniformly distributed and had the greatest percentage below 7.5 cm in the soil. Dinitroaniline herbicide effects on the interaction between the *Rhizobium* organism and the soybean root system, resulting on occasion in decreased nodulation, apparently is of significance to yield only when the herbicide results in phytotoxicity to the soybean plant.

Physiology. Changes in dry weight and nitrogen content of various components of Harcor and Harosoy 63 during the growing season indicate that in the bean-filling stage, the leaves are the biggest supplier of both dry weight and nitrogen. In the production of bean yield, soybean leaves need to be regarded as a major source of stored materials as well as a photosynthetic surface.

Phytophthora root rot. Percentage plant loss in the Woodslee tolerance test area was determined to be a highly heritable characteristic suitable for tolerance selection. Combining race-specific resistance with tolerance should prove to be the most effective means of controlling this disease.

A gene, designated Rps_5, was identified in L62-904 as giving resistance to races 1–5 and 8–9 of *Phytophthora megasperma* f. sp. *glycinea.*

Weed control. Seven chemical treatments were given full recommendation status by the Expert Committe on Weeds (Eastern Canada Section) based partly on research conducted on the clay soil at Woodslee. Four new grass-control herbicides were successfully evaluated for their ability to control volunteer corn in soybeans. The most effective material controlled corn at the three- to four-leaf stage at a rate as low as 0.0375 kg/ha, or one-tenth the recommended amount for annual grass control.

Burley tobacco

Black root rot. Losses caused by black root rot, *Thielaviopsis basicola*, have been considerable in certain production areas during the past few years. A technique using inoculum produced on sorghum seed was developed to enable a uniform evaluation of varieties under field conditions. The variety Kentucky 17 was found to be twice as tolerant of the disease as varieties currently grown, but it was unacceptable agronomically. A permanent nursery has been established to evaluate tolerance for black root rot and to conduct trials for determining agronomic suitability of introduced lines and varieties.

White beans

Anthracnose. Although the anthracnose fungus (*Colletotrichum lindemuthianum*) can survive several years in dry beans and dry infected debris, it lost its viability by mid-May of the following year in infected debris buried in the field in November. Clean seeds sown in a field with heavy infection in the previous season developed no disease.

Breeder seed for the new delta anthracnose-resistant Fleetwood, Kentwood, and Seafarer was increased for distribution. Yields of the new resistant cultivars were comparable to those obtained from the corresponding cultivars that were originally susceptible to the delta race.

Bacterial blight. In field evaluations of 17 selected lines at Harrow, 11 were found to be tolerant of bacterial blight, *Xanthomonas campestris* pv *phaseoli*, two of these outstanding. These two matured as fast as the recommended cultivars Kentwood and Fleetwood, respectively, and outyielded them.

Under conditions of high inoculum pressure in selected seed plots, control of bacterial blight was obtained with five weekly sprays of copper hydroxide (Kocide-101, 2.24 g/L), Kocide-101 plus mancozeb (Dithane M-45, 1.12 g/L each), and the flowable formulations of tribasic copper sulfate (super-Cu, 3 mL/L) plus maneb (Manex, 5.25 mL/L). However, these treatments did not meet the zero-blight tolerance required in the select seed plots.

White mold. The cultivar Ex Rico 23, which originated in Columbia, was identified as the first white bean cultivar highly tolerant of white mold, *Sclerotinia sclerotiorum.* In fields with severe white mold, Ex Rico 23 had a consistently lower incidence of disease and a slower rate of spread of disease than the other recommended cultivars, Fleetwood, Kentwood, and Seafarer, which all suffered severe infection and yield loss. Fleetwood had 75% of plants infected, but Ex Rico 23 had only 7%. Ex Rico 23 is now being used in a breeding program as a source of white mold tolerance.

Winter wheat

Breeding. A selection out of the cross Fredrick × Yorkstar outyielded its highest yielding parent, Fredrick, by 23% and had equal or better survival, test weight, and height. Its resistance to lodging was outstanding, with an index of 0.25, compared with 1.75 for Fredrick and 2.25 for Yorkstar. A quality test of an earlier generation indicated that this line has improved flour protein and viscosity (both lower). Lines with good seed quality and with good resistance to wheat spindle streak mosaic virus and to lodging are entered in the Ontario screening tests.

HORTICULTURAL CROPS

Field vegetables

Crucifer crops

Chinese cabbage protection. Cabbage maggots were adequately controlled by the recommended treatment for cabbage or cauliflower, but seed-corn maggots infesting the heads in June were not. Twice-weekly sprays of insecticides reduced infestation of the heads to 4% in June, but because these could not be sorted by external examination, such a damage level was still unacceptable.

Monitoring for leaf-eating insects. In a study to develop a monitoring system for crucifer crops, field plots of late-season cabbage were treated with microbial or chemical insecticides when populations of larvae of the cabbage looper and cabbageworm on plants, determined by twice-weekly monitoring, exceeded preestablished thresholds. Damage to the crop at harvest indicated that application of insecticides when population densities exceeded 0.5 larva (second instar or larger) per plant early in the season and 0.25 larva per plant near harvest gave acceptable protection of the crop. Permethrin was applied five times and microbial insecticides (against *Bacillus thuringiensis* and viruses of the cabbage looper and cabbageworm) were applied six times during the season to plots treated on the basis of these thresholds.

Cucumbers

Weed competition. The critical period of weed competition in pickling cucumbers is a function of the relative growth rate of the crop and the weed population per unit area. Management techniques can alter the critical period and therefore influence the optimum timing of weed control. Cucumbers grown in rows 1 m apart require only 2–3 wk of weed-free maintenance, as compared with 4–5 wk for cucumbers grown in rows 2 m apart. Later-emerging weeds did not achieve relative growth rates per unit area equivalent to that of the crop and were not able to suppress crop growth.

Green and wax beans

First-generation corn borer damage to green and wax beans. For the first time, green and wax beans were found to be infested by large European corn borer larvae when they were harvested in July. The larvae in the beans originated in large tunnels in the stems, because there were no beans on the plants when the larvae hatched from eggs. This was a significant departure from normal; past experience showed damage to occur after second-generation moth flights start in late July, with larvae entering the beans directly and being found in harvests in August. Azinphos-methyl, methomyl, and carbaryl were applied by helicopter to avoid damage by ground equipment. Although the amount of water used had to be greatly reduced for helicopter application, the deposits proved adequate for control of the young, hatching larvae but not for large larvae. Differences in the susceptibility of varieties were observed when corn borer larvae were introduced artificially. Though the level of damage was significantly less on Pico (7%) than on the varieties Early Gallatin (18%) and Gold Rush (17%), the corn was still unacceptable for freezing.

Onions

Weed control. Weed control on transplanted onions was evaluated on mineral soils for the first time at Harrow in 1981. An outstanding treatment of chlorpropham post-transplanting followed 4 wk later by oxyfluorfen gave 98–100% control of all weeds during the growing season, with no observable injury to the onions.

Peppers

Corn borer moth age and pepper damage. The average postmating age reached by female European corn borer moths from light traps varied from 3.4 to 5.2 days in the June–September flight period at Harrow, in a

manner consistent with assignment of moths to three generations a year. At the beginning of the first generation the mean age was 3.66 days and rose to 5.21 before flights ceased. At the beginning of the second generation the mean age was 3.39 days and rose to 4.47 days. A third generation could be detected in early September by a significant drop in age, not accompanied by any interruption in catches. The average age of mated females was negatively correlated with the proportion of virgin females in the same week ($r = -0.648$, $P = 0.02$), indicating that about 40% of the variance in age of mated females was associated with emergence of new recruits to the population. Moth age was found to be insignificant when tested as a factor in forecasting damage caused by their progeny in peppers 3–5 wk later.

Sweet corn

Varietal resistance to first-generation corn borer. In 1981 four more varieties of early sweet corn were identified as having excellent resistance to ear damage by first-generation European corn borer. Seven hybrids had less than 3% damaged ears compared with 24% damage to Seneca 60. These varieties can be grown without the usual three or four insecticide sprays.

Tomatoes

Bacterial speck. Several fruit symptoms that vary considerably from the typical black superficial specks are now recognized as indicative of bacterial speck (caused by *Pseudomonas syringae* pv *tomato*). At Harrow, natural incidence of bacterial speck on the fruit of processing cultivars was the lowest (20%) in Campbell-28 and over 50% in Veepro, Heinz 2653, Chico III, Ohio 7663, Hunts 304, Ferry-Morse 6203, and VF 134-11. There was no apparent influence of irrigation or plant density on the incidence of fruit symptoms.

Bacterial spot. In a cooperative evaluation of 250 tomato accessions at the Horticultural Experiment Station, Simcoe, Ont., with Dr. E. A. Kerr of Ontario Ministry of Agriculture and Food, 46 were found to be tolerant of bacterial spot (caused by *Xanthomonas campestris* pv *vesicatoria*) in greenhouse and field assessments on foliage and fruit.

Water relation and yields. Irrigation studies were conducted with the tomato cultivars (H2653 and C28) on Fox sandy loam in 1979 and 1980. Total marketable yields of both cultivars were similar among irrigation treatments. Though accumulated evapotranspiration increased with increasing irrigation frequency, the yield response to irrigation frequency was minimal; consequently, an excessive amount of water resulted in lower water use efficiency.

Plant density treatments had more important effects on increasing yield than did irrigation treatments in both years, suggesting that when transplanted tomatoes are grown in this region during years of normal and above average rainfall, yield can be increased by increasing plant density above 16 000 plants per hectare without causing much competition for water. More studies are needed on the effects of irrigation and plant density on tomato production when the rainfall is below normal during the growing season.

Water uptake by tomato roots. Tomato plants were grown in specially designed sectional treatment boxes that divided the root system into four separate quadrants. Transpiration, photosynthesis, and stomatal conductance were determined in tomato plants with four, three, two, and one quadrants of the root system supplied with water. The shoot-to-root ratio of tomato plants increased as the proportions of roots supplied with water increased. The application of water to only 50 or 75% of the root system did not reduce transpiration, photosynthesis, stomatal conductance, or leaf surface area, compared with a fully watered plant. Where a substantial part of the root system (75%) was subjected to moisture stress, only a small reduction in transpiration rate (20%) was observed. These results indicate that a portion of the roots of tomato plants had sufficient absorptive capacity to meet evapotranspirational demand when a substantial part of the root system was subjected to moisture stress.

Weed control. Weed control in direct-seeded tomatoes was not influenced by the method of planting (gel, plug-mix, or dry seed). Trifluralin plus diphenamid shallowly preplant-incorporated, followed by metribuzin postemergence on four-leaf tomatoes, gave the best weed control either on sand soil or on clay soil beds.

Yellow nutsedge control and physiology. One out of five yellow nutsedge biotypes has been found to be more effectively controlled by vernolate than by another thiocarbamate

herbicide, EPTC, contrary to normal sensitivity ratings. Another biotype was also shown to be more insensitive than usual to both these herbicides. These results may partly explain the occasional report of ineffective control of nutsedge by farmers.

The cause of the innate dormancy of yellow nutsedge tubers was investigated by assessing the respiratory capability of mitochondria from such tissue. Although isolated mitochondria can metabolize the respiratory substrate succinate, they cannot appreciably oxidize α-ketoglutarate or isocitrate. The metabolism of the oil reserves may proceed via the glyoxylate cycle, with free fatty acids contributing to the suppressed state.

Greenhouse vegetables

Cucumber

Cucumber black root rot. Not recorded before in Ontario and only rarely elsewhere in North America, black root rot caused by the fungus *Phomopsis sclerotioides* Kest. was widespread and serious in Essex County greenhouses. The disease was associated with the cool soils now common in energy-saving programs; it was exacerbated by applying straw mulch before the sun warmed the soil and by irrigating with cold water.

Cucumber gummy stem blight. This disease, also new to Ontario and also widespread and severe, is caused by the fungus *Didymella bryoniae* (Anersw.) Rehm. Lesions of the stem also often contained *Botrytis cinerea* and a *Fusarium* sp. of uncertain etiology. Its control presents a dilemma: of the registered fungicides, only benomyl is effective against *D. bryoniae*, but both *B. cinerea* and the powdery mildew caused by *Sphaerotheca fuliginea* are tolerant of that fungicide in the area.

Tomatoes

Crop management. Investigations into the use of plastic bags filled with amended peat for cropping greenhouse tomatoes have provided encouraging results. A growing medium has been formulated based on a fertilized mixture of peat vermiculite and perlite, and a fertilization schedule has been developed to suit that medium. This newly developed peat bag system for tomato cropping is easy to manage and complete. In extensive experiments conducted so far, the productive capacity of this system has compared favorably with commercial peat bag systems, as well as with conventional soil production methods.

Fusarium foot and root rot. In cooperative work with Dr. E. A. Kerr of Ontario Ministry of Agriculture and Food, 65 breeding lines of pink tomato were screened for resistance; 30 showed some degree of resistance and are being assessed further for agronomic quality.

Tree fruits

Apricot

Breeding. Four promising selections (HW425, HW436, HW433, and HW437) were propagated for entry into grower trials in 1983 because of their continued good performance in trials at Harrow. They ripen from midseason to late in the season. HW437 received the highest performance rating of any cultivar or advanced selection that ripens late in the season (6 August). The fruits of this selection ripen 3 wk after Harcot, which is the earliest ripening cultivar now being recommended for commercial culture.

Nectarine

Breeding. A new nectarine selection (H7561037) was made from progeny of the cross of a cold-hardy Harrow introduction (Hardired) with a large-fruited, high-quality introduction from California (Flavortop). This selection showed remarkable field tolerance for bacterial spot, caused by *Xanthomonas pruni* (E. F. Sm.) Dowson, and brown rot, caused by *Monilinia fructicola* (Wint.) Honey, in a year when both diseases were especially severe. The fruits also exhibited noteworthy resistance to skin cracking in an exceptionally wet season, when this disorder was common on most nectarines. Besides these attributes, this selection was cold-hardy and very productive, with firm-fleshed, attractive, flavorful fruit.

Peach

Breeding. Seven promising new selections were made in 1981, four of which ripened their fruit in mid- to late-August and three early in September to mid-September. H7603017 was especially promising, because besides being more cold-hardy than Redhaven, the hardy standard, its fruit ripened 5

days later than the latest commercial cultivar, Reskin; this selection shows promise for extending the season for fresh-market peaches by at least a week. Seventeen selections previously made in 1980 were found to be more cold-hardy than Redhaven in controlled freezing tests and have been retained for further study. Two selections in regional trials, HW227 and H781, performed exceptionally well in 1981 and are being considered for commercial introduction in 1983 if cold-hardiness levels prove to be sufficient for southwestern Ontario.

Simazine soil persistence. Simazine applied as a wettable powder to a sandy loam soil degraded fairly rapidly over the growing season with a half-life of 29–40 days. Degradation in Fox and Granby sandy loam soils was independent of soil moisture content from 3.4–18.4% (wt/wt) but was dependent on soil temperature (activation energy 49.8 kJ/K per mole). Simulated simazine persistence values, calculated from a herbicide degradation model using the calculated activation energy and data on local air temperature and precipitation, exceeded measured persistence values by 26%. The model accurately predicted soil moisture content from the precipitation data, which suggested that other unknown factors were responsible for the poor agreement between simulated and measured persistence.

Water relation and growth. The relationship between leaf water potential, stomatal conductance, and rates of transpiration and photosynthesis were determined for 1-yr-old peach seedlings in a growth room. Under our experimental conditions, stomatal diffusive resistance (reciprocal of stomatal conductance) remained relatively low until leaf-water potential fell between −2.9 and −3.5 MPa, then increased rapidly with further decreases in leaf-water potential. Our observation gives some support to the idea of a critical value for leaf-water potential, below which stomatal diffusive resistance increases rapidly. However, if one considers stomatal conductance, there was no evidence for a critical value. Stomatal conductance, transpiration, and photosynthesis all declined steadily with decreasing leaf-water potential, thus suggesting that water loss, photosynthesis, and (presumably) growth all start to decline as soon as water stress appears.

Weed competition. Weed competition in the year of transplanting may be reflected in smaller trees in succeeding years. A 61% reduction was measured in trunk diameter of peach trees in the year of transplanting compared with trees kept weed free. Trees kept free from weeds all showed a comparable percentage increase in trunk diameter the following year regardless of the treatment used. However, trees that had to contend with weed competition the year before treatment had trunk diameters 11 mm smaller than those kept weed free throughout.

Weed control. Trifluralin and metribuzin preplant incorporated at 2 and 0.75 kg/ha, respectively, controlled weeds in transplanted peach trees without effect on the trees. Herbicide residues dissipated by the end of the growing season. If registration of these herbicides were extended to transplanted peach trees, vegetable crops (for example, tomatoes) could be grown between the rows of trees, thus permitting cash returns during years of orchard establishment.

Weed control in fruit nurseries. Granular simazine applied at 2.2–2.5 kg/ha using a modified Gandy applicator provided excellent control of annual broad-leaved weeds and good control of annual grasses in tree fruit nurseries of peach, pear, and apricot with consistent tree safety except for pear, which had slight and moderate leaf chlorosis in 2 yr, respectively. The application of granular simazine at 1.1–1.3 kg/ha in conjunction with a prior or simultaneous application of napropamide at 4.0–4.5 kg/ha resulted in excellent control of broad-leaved weeds and grasses. Soil residues resulting from the use of granular simazine at 2.2–2.5 kg/ha were such that injury to subsequently planted crops might be anticipated, but the application of the lower rate greatly minimized this hazard.

Pear

Breeding. Two new fireblight-resistant cultivars named Harrow Delight and Harvest Queen were introduced in 1981. Both cultivars have sufficient resistance to fireblight (*Erwinia amylovora* (Burr.) Winslow et al.) that special sprays are not required to control the disease. Harrow Delight and Harvest Queen are adapted not only to the pear-growing regions of Ontario, but also to Nova Scotia, British Columbia, and adjacent states of the United States. Harrow Delight can be picked for ripening 2 wk before Bartlett, whereas Harvest Queen can be picked a week before Bartlett. The fruits of both cultivars

are very good in flavor and texture when fresh and are suitable for processing as canned halves in syrup or as puree.

Fireblight monitoring and resistance. Strains of *Erwinia amylovora* vary in their virulence, but there is no major interaction of bacterial strain with pear progenies in the breeding program. General combining ability for fireblight resistance appears to be much higher than specific combining ability. Inheritance seems polygenic, with considerable additive genetic action.

Monitoring orchards for epiphytic *E. amylovora* cannot be relied upon to predict outbreaks of fireblight in southwestern Ontario. Epiphytic *E. amylovora* could be detected in only four of the apple and pear orchards, although fireblight occurred later in all of them. Hold-over cankers were more numerous in pears than in apples.

PUBLICATIONS

Research

Bolton, E. F.; Dirks, V. A.; Hore, F. R. 1980. Corn, soybean and wheat yields on Brookston clay drained by plastic tubing installed by two methods at seven spacings and two depths. Can. Agric. Eng. 22:145-148.

Bonn, W. G. 1981. Monitoring of epiphytic *Erwinia amylovora* and the incidence of fire blight of apple and pear in southwestern Ontario. Acta Hortic. 117:31-36.

Buttery, B. R.; Buzzell, R. I.; Findlay, W. I. 1981. Relationships among photosynthetic rate, bean yield and other characters in field-grown cultivars of soybean. Can. J. Plant Sci. 61:191-198.

Chu, W. H.; Jaques, R. P. 1981. Factors affecting infectivity of *Vairimorpha necatrix* (Microsporidia: Nosematidae) in *Trichoplusia ni* (Lepidoptera: Noctuidae). Can. Entomol. 113:93-102.

Colwell, H. T. M.; O'Sullivan, J. 1981. Economics of harvest timing for harvesting of cucumbers. J. Am. Soc. Hortic. Sci. 106:163-167.

Dirks, V. A.; Bolton, E. F. 1981. Climatic factors contributing to year-to-year variation in grain yield of corn on Brookston clay. Can. J. Plant Sci. 61:293-305.

Elliott, W. M. 1981. The relationship of embryo counts and suction trap catches to populations dynamics of *Macrosiphum euphorbiae* (Homoptera: Aphididae) on tomatoes in Ontario. Can. Entomol. 113:1113-1122.

Foott, W. H.; Timmins, P. R. 1981. Effects of a natural bivoltine strain of the European corn borer, *Ostrinia nubilalis* (Lepidoptera: Pyralidae), on grain corn yields in southwestern Ontario, 1973–77. Can. Entomol. 113:585-591.

Gaynor, J. D.; MacTavish, D. C. 1981. Pentafluorobenzyl, trifluoromethylbenzyl and diazomethane alkylation of bentazon for residue determination in soil by gas chromatography. J. Agric. Food Chem. 29:626-629.

Gaynor, J. D.; Volk, V. V. 1981. Runoff losses and atrazine and terbutryn from unlimed and limed soil. Environ. Sci. Tech. 15:440-443.

Gaynor, J. D.; Volk, V. V. 1981. s-Triazine solubility in chloride salt solutions. J. Agric. Food Chem. 29:1143-1146.

Ihnat, M.; Gordon, A. D.; Gaynor, J. D.; Berman, S. S.; Desaulniers, A.; Stoeppler, M.; Valenta, P. 1980. Interlaboratory analysis of natural and fresh waters for copper, zinc, cadmium and lead. Int. J. Environ. Anal. Chem. 8:259-275.

Jaques, R. P.; Laing, J. E.; MacLellan, C. R.; Proverbs, M. D.; Sanford, K. H.; Trottier, R. 1981. Apple orchard tests on the efficacy of the granulosis virus of the codling moth, *Laspeyresia pomonella* (Lep.: Olethreutidae). Entomophaga 26:111-118.

Jaques, R. P.; Morris, O. N. 1981. Compatibility of pathogens with other methods of pest control and with different crops. Pages 695-715 *in* H. D. Burges, ed. Microbial control of insects, mites and plant diseases. Vol. 2. Academic Press, London. 949 pp.

Jarvis, W. R.; Thorpe, H. J. 1981. Control of fusarium foot and root rot of tomato by soil amendment with lettuce residues. Can. J. Plant Pathol. 3:159-162.

Khan, S. U.; Marriage, P. B.; Hamill, A. S. 1981. Effects of atrazine treatments of a corn field using different application methods, times, and additives on the persistence of residues in soil and their uptake by oat plants. J. Agric. Food Chem. 29:216-219.

Laing, D. R.; Jaques, R. P. 1980. Codling moth: techniques for rearing larvae and bioassaying granulosis virus. J. Econ. Entomol. 73:851-853.

Layne, R. E. C. 1981. 'Hargrand' apricot. HortScience 16:98-100.

Layne, R. E. C. 1981. 'Harlayne' apricot. HortScience 16:97-98.

Layne, R. E. C. 1981. Harrow Frostipink, Harrow Candifloss and Harrow Rubirose ornamental peaches. Can. J. Plant Sci. 61:157-159.

Layne, R. E. C.; Tan, C. S.; Fulton, J. M. 1981. Effect of irrigation and tree density on peach production. J. Am. Soc. Hortic. Sci. 106:151-156.

Levin, D. B.; Laing, J. E.; Jaques, R. P. 1981. Interactions between *Apanteles glomeratus* (L.) (Hymenoptera: Braconidae) and granulosis virus in *Pieris rapae* (L.) (Lepidoptera: Pieridae). Environ. Entomol. 10:65-68.

Liptay, A.; Jaworski, C. A.; Phatak, S. C. 1981. Effect of tomato transplant stem diameter and ethephon treatment on tomato yield, fruit size and number. Can. J. Plant Sci. 61:413-415.

Marriage, P. B.; Khan, S. U.; Warwick, S. I.; Tutte, D. F. 1981. Differential nitrogen response to atrazine of susceptible and resistant populations of lamb's-quarters (*Chenopodium album* L.). Pestic. Biochem. Physiol. 15:294-299.

McClanahan, R. J. 1981. Effectiveness of insecticides against the Mexican bean beetle. J. Econ. Entomol. 74:163-164.

McKeen, C. D.; Thorpe, H. J. 1981. Verticillium wilt of potato in southwestern Ontario and survival of *Verticillium albo-atrum* and *V. dahliae* in field soil. Can. J. Plant Pathol. 3:40-46.

Pandeya, R. S.; Rosa, N.; Dirks, V. A. 1981. Relationship between green and cured leaf total alkaloids of topped and untopped plants in relative ranking of flue-cured tobacco genotypes (*Nicotiana tabacum* L.). Tob. Sci. 25:42-47.

Phatak, S. C.; Jaworski, C. A.; Liptay, A. 1981. Flowering and adventitious root growth of tomato cultivars as influenced by ethephon. HortScience 16:181-182.

Russell, L. F.; Quamme, H. A.; Gray, J. I. 1981. Qualitative aspects of pear flavor. J. Food Sci. 46:1152-1158.

Smith, B. C. 1981. Effect of soil application of carbofuran on egg populations of the northern corn rootworm (Coleoptera: Chrysomelidae). Can. Entomol. 113:73.

Tan, C. S.; Cornelisse, A.; Buttery, B. R. 1981. Transpiration, stomatal conductance, and photosynthesis of tomato plants with various proportions of root system supplied with water. J. Am. Soc. Hortic. Sci. 106:147-151.

Tan, C. S.; Fulton, J. M. 1981. Estimating evapotranspiration from irrigated crops in southwestern Ontario. Can. J. Plant Sci. 61:425-435.

Tan, C. S.; Layne, R. E. C. 1981. Application of a simplified evapotranspiration model for predicting irrigation requirements of peach. HortScience 16:172-173.

Thorpe, H. J.; Jarvis, W. R. 1981. Grafted tomatoes escape Fusarium foot and root rot. Can. J. Plant Sci. 61:1027-1028.

Tu, J. C. 1981. Anthracnose (*Colletotrichum lindemuthianum*) on white bean (*Phaseolus vulgaris* L.) in southern Ontario: Spread of the disease from an infection focus. Plant Dis. 65:477-480.

Tu, J. C. 1981. Effect of salinity on rhizobium–root–hair interaction, nodulation and growth of soybean. Can. J. Plant Sci. 61:231-239.

Tu, J. C. 1981. Identification of a severe bean strain of tobacco ringspot virus isolated from white beans *Phaseolus vulgaris* L. Phytopathol. Z. 101:153-162.

Tu, J. C.; Vaartaja, O. 1981. The effect of the hyperparasite (*Gliocladium virens*) on *Rhizoctonia solani* and on *Rhizoctonia* root rot of white beans. Can. J. Bot. 59:22-27.

Miscellaneous

Bolton, E. F.; Dirks, V. A.; Hore, F. R. 1981. Closer drain spacings for higher yields. Canadex 752.

Foott, W. H.; McLeod, D. G. R. 1981. European corn borer. Ontario Ministry of Agriculture and Food Factsheet 111/622.

Jarvis, W. R. 1981. Control of plant diseases with antagonistic organisms. Proc. Can. Pest. Manage. Soc. 28:43-45.

Lang, H. C.; Buzzell, R. I.; Beversdorf, W. D. 1980. Soybean production. Ontario Ministry of Agriculture and Food Publ. 173 (revised).

Pandeya, R. S.; Dirks, V. A. 19?1. The role of statistics in tobacco genetics and breeding. Proc. "Statistics in Canada '81,' Concordia University, April 1981.

Pandeya, R. S.; Dirks, V. A.; White, F. H. 1981. Path coefficient analysis of variation in smoke wet tar and nicotine in relationship to certain agronomic and chemical characteristics (*Nicotiana tabacum* L.). Proc. "Statistics Canada '81," Concordia University, April 1981.

Tu, J. C. 1981. Damping-off and root rot of white beans. Canadex 142.630.

Tu, J. C. 1981. Fungal diseases of white (snap, kidney) beans. Agdex 255.630.

Welacky, T. W. 1981. Burley tobacco harvest mechanization. The Lighter 51(1):26-29.

Welacky, T. W. 1981. Burley tobacco variety performance: 1977–79 agronomic, physical and chemical results. The Lighter 50(3):22-31.

Research Station
Ottawa, Ontario

PROFESSIONAL STAFF

T. Rajhathy, Ing. Agr., M.Sc., D.Agr.Sci., F.R.S.C.	Director
J. G. R. Loiselle, B.Sc. (Agr.), M.Sc., Ph.D.	Plant gene resources of Canada
B. W. Jablonski, B.L.A.	Landscape Architect
R. Porteous	Head, Administration and resources
C. McCarthy	Finance and general services

Cereal Crops

V. D. Burrows, B.S.A., M.Sc., Ph.D.	Head of Section; Oat breeding
V. Clark, B.Sc. (Agr.), M.Sc., Ph.D.	Oat and barley pathology
J. Frégeau, B.Sc., M.Sc., Ph.D.	Crop physiology
R. G. Fulcher, B.Sc., M.Sc., Ph.D.	Morphogenetics and grain quality
K. M. Ho, B.Sc., M.Sc., Ph.D.	Barley breeding
D. R. Sampson, B.Sc., A.M., Ph.D.	Wheat breeding
W. L. Seaman, B.Sc., Ph.D.	Wheat pathology

Cytogenetics

G. Fedak, B.S.A., M.Sc., Ph.D.	Head of Section; Cereal cytology
K. C. Armstrong, B.S.A., Ph.D	Brome cytology and chromosome banding
I. L. Craig, B.S.	*Hordeum* cytology
B. E. Murray, B.S.A., M.Sc., Ph.D.	Haploidy—flax cytology

Entomology

D. G. Harcourt, B.S.A., Ph.D.	Head of Section; Population dynamics
R. Boch, Dr. Rer. Nat.	Physiology and behavior of bees
T. A. Gochnauer, B.S., M.S., Ph.D.	Pathology of bees
J. C. Guppy, B.S.A., M.S.	Population dynamics
C. C. Loan, B.A., M.S., Ph.D.	Population dynamics
F. Meloche, B.Sc., M.Sc.	Population dynamics

Forage Crops

L. S. Donovan, B.S.A., M.S., Ph.D	Head of Section; Corn breeding
P. K. Basu, B.Sc., M.Sc., Ph.D.	Plant disease
M. A. Faris, B.Sc., M.Sc., Ph.D.	Legume breeding
W. R. McElroy,[1] M.Sc., B.Sc.	Grass breeding
H. D. Voldeng, B.S.A., M.Sc., Ph.D.	Soybean breeding
F. S. Warren, B.S.A., M.Sc., Ph.D.	Agronomy

Genetic Engineering

W. A. Keller, B.S.A., Ph.D.	Head of Section; Cell genetics
D. Brown, B.Sc., M.Sc., Ph.D.	Developmental physiology
B. L. A. Miki, B.Sc., Ph.D.	Molecular genetics
S. J. Molnar, B.Sc., M.Sc., Ph.D.	Cell genetics

Ornamentals

E. V. Parups, M.S.A., Ph.D.	Head of Section; Physiology and floriculture
A. T. Bolton, B.Sc., M.Sc., Ph.D.	Pathology
S. Nelson, B.Sc., M.Sc., Ph.D.	Nursery research
J. A. Simmonds, B.Sc., M.Sc.,Ph.D.	Physiology and floriculture
F. J. Svejda, Ph.D.	Plant breeding

Experimental Farm, Kapuskasing, Ont.

J. G. Proulx, D.V.M.	Superintendent; Crop and beef management

Experimental Farm, Thunder Bay, Ont.

J. Wilson	Superintendent; Crop management and evaluation

Departures

L. Dessureaux, B.A., B.Sc., M.S., Ph.D. Retired December 1981	Alfalfa genetics
S. O. Fejer, Ing. Agr., Dr. Sc. Tech. Retired December 1981	Barley breeding

VISITING SCIENTISTS

A. ATANASSOV, Ph.D. From November 1981 to May 1982	Tissue culture
D. BROWN, M.Sc., Ph.D. From June 1981 to September 1982	Selection of mutants
B. GILES, B.Sc., M.S., Ph.D. From June 1981 to May 1982	*Hordeum* cytogenetics
K. KLIMASZEWSKA, M.Sc., Ph.D. From December 1981 to November 1982	Tissue culture
C. NAKAMURA, B.Sc., M.Sc., Ph.D. From 1979 to March 1981	Cereal tissue culture
J. M. YEE, B.Sc., M.Sc., Ph.D. From October 1981 to October 1982	Dynamics of insect populations

Graduate student

S. GLEDDIE, B.Sc.	Somatic hybridization

---

[1]On educational leave, University of Guelph, Guelph, Ont., from September 1980 to June 1982.

INTRODUCTION

The Ottawa Research Station (ORS) is the major center for plant breeding in eastern and central Ontario as well as for western Quebec. It is the major center for ornamentals research in the Research Branch. The Canadian Plant Gene Resources is a national program, and a small unit is engaged with studies of honeybee behavior and pathology. In addition, the Station is charged with numerous service functions and the management of the entire Central Experimental Farm.

The breeding programs are supported by multidisciplinary research including plant genetics and somatic cell genetics, cytogenetics, plant physiology and pathology, entomology, cytochemistry, and morphogenetics. Agronomy provides important information for improved crop management, and a grain quality laboratory is servicing all the breeding programs. The scope of landscape architecture includes the beautification of the campus of the Central Experimental Farm, the planning of the annual chrysanthemum show, and landscape planning for Agriculture Canada buildings across the country.

The Experimental Farm at Kapuskasing continues to conduct experiments on crop production and on beef-cattle management for northwestern Quebec and northeastern Ontario. The Experimental Farm at Thunder Bay is engaged in methods of crop production for northwestern Ontario.

A number of cultivars in several species obtained license and were released: Valor, a hard red utility winter wheat adapted to the Maritime region; Maple Amber, a high-quality soybean of mid-season maturity (in the short-season range), and Nattawa, a food-class soybean for natto processing. Three corn hybrids also obtained license and were released for production. The integrated pest management (IPM) system for the alfalfa weevil, tested in the Bay of Quinte area, was successfully extended to western Ontario, and a computerized monitoring system for IPM field scout was established. Critical chromosomes with genes for crossability of wheat with barley were identified.

Dr. S. O. Fejer, barley geneticist and breeder, retired after 20 yr, and Dr. L. Dessureaux, alfalfa geneticist, retired after 34 yr of distinguished service.

This report summarizes some of the more important research results from the Station in 1981. Further information can be obtained from the publications listed at the end of this report. Reprints of the research publications and copies of this report are available on request from the Ottawa Research Station, Research Branch, Agriculture Canada, Ottawa, Ont. K1A 0C6.

Tibor Rajhathy
Director

CEREAL CROPS

Wheat

Breeding. Developing improved soft white winter wheat for Ontario remains the chief objective, but Ottawa Research Station (ORS) also has a mandate to breed winter wheats for Eastern Canada. In 1981, ORS, jointly with the Charlottetown Research Station, licensed and released the cultivar Valor, a new red winterfeed wheat for the Maritimes. Valor came from a wheat × rye cross, and for most of its 6-yr of testing it proved marginally superior to Lennox in yield, test weight, 1000-kernel weight, winter survival, and mildew resistance.

White kerneled wheats are especially prone to sprouting in the field and the Ontario crop suffers about 3% damage 1 yr in every 5 yr. In 1981, however, an untimely rain just before harvest caused sprouting in the ear of an uprecedented 40% of the crop. Current efforts at ORS to breed for sprouting resistance focus on a rare type of seed dormancy found at the Winnipeg Research Station in the white spring wheat Kenya 321. In 1981, we selected 40 resistant plants in the F_2 of Fredrick × Kenya 321 by exposing ears of over 1300 plants to simulated rain. These 40 have many shortcomings as pastry wheats: they lack mildew resistance and more than half lack the winter growth habit, but their high grain

protein levels give the most concern. Only five had protein as low as the low parent, Fredrick, and 23 of the 35 tested had higher protein than either parent. Low protein is required for pastry wheat.

Pathology. Despite the loss of protective snow cover following heavy rains in February, most winter wheat fields in Ontario escaped damage from cold temperatures. The lack of snow cover in spring also resulted in very little snow mold damage, with only scattered problem areas in Renfrew and Simcoe counties. Barley yellow dwarf was not a problem in wheat in 1981, and only late-seeded spring cereals were seriously affected by this disease in localized areas. In the Niagara Peninsula, widespread yellowing and stunting of winter wheat that could not be attributed to infection by wheat spindle streak mosaic virus occurred in early spring, although incidence of that virus disease was relatively high in the southwestern countries.

Prematurity blight, causing white heads, was again prevalent, and for the first time in Ontario some of the symptoms were caused by larvae of the European corn borer, *Ostrinia nubilalis* (Hübner).

Leaf diseases and glume blotch were present in most areas at heading; however, development of scab caused by *Fusarium* spp. was limited by relatively dry weather at harvest; and mycotoxin production, which occurred during the rain-delayed harvest in 1980, was generally not a problem in Ontario.

Barley

Breeding. Two ORS six-row feed cultivars, Massey and Vanier, continue to be the highest-yielding licensed cultivars in Ontario, and they are resistant to smut, mildew, and scald. A new selection, OB 294-1 (Léger), will likely be licensed in 1982, and all performance data indicate that it represents a major step forward in combining high yield with overall desirable agronomic performance. It will likely become the new standard for barley cultivars in Eastern Canada. Seed of OB 294-1 will become available to producers in 1984. The ORS barley breeding program is healthy and six more productive entries are being evaluated in the cooperative test.

The two-row barley breeding program is not as old or as extensive as the six-row program, but OB 440 performed well and could reach cultivar status in 1983. It is a short- and strong-strawed, large-seeded two-row barley.

Oats

Breeding. The ORS oat breeding program is extensive and diversified, and it has as its major goal the improvement of oats both as a feed and as a food grain. Breeding research has been concentrated on raising the yield potential of oats by conventional breeding and by breeding novel classes of oats such as dormoats, daylength-insensitive oats, and naked oats. Dormoats possess seed dormancy genes from *Avena fatua* L. and are intended for planting in the fall. Fall-sown dormant seed hold their dormancy over winter but germinate in the spring and grow to produce high yields. In addition to breeding, physiological studies were initiated to determine if the induction of thermodormancy in seeds in the fall prior to sowing will be useful to help manage the crop.

A request to license OA 366 will be made in 1982, and this oat will represent the first Canadian cultivar produced from the ORS daylength-insensitive research program initiated in 1965. It represents improvements in yield, seed size, thinness of hull, early maturity, smut, and barley yellow dwarf resistance compared to cultivars recommended in Ontario. The cultivar OA 366 should be useful as both a feed oat for farmers and as a milling oat for food processors.

Naked oats free from adhering hulls are being bred to produce a high-energy high-protein grain that can be stored and shipped economically to both domestic and export markets. Superior tall and dwarf type strains have been produced and several strains are in advanced stages of testing. New true breeding semidwarf strains were isolated for the first time in 1981, and several of these possess unusually productive spikelets (10–14 florets). Canadian hull-less oats have been given the name Cavena (Canadian *Avena*) to distinguish them from normal-covered oats.

Pathology. The oat crop in eastern Ontario and western Quebec suffered severe damage from crown rust (*Puccinia coronata* Cda. f. sp. *avenae* Erikss. & Henn.) in 1981, similar to that of the previous year. A field tolerance test with 45 cultivars was conducted again, employing maneb (Dithane M-22) fungicide to control leaf disease. It showed that losses from natural infection by crown rust amounted to a 29% reduction in kernel

weights. Inoculation with septoria (*Septoria avenae* Frank f. sp. *avenae*) affected only a few cultivars and, on the average, caused no additional loss in kernel weight. Two cultivars showed no difference between fungicide-treated and naturally infected plants. However, numerous cultivars showed much higher levels of tolerance than others. A second test was run, employing the experimental fungicide CGA 64250 (Tilt) to control rust. It was found that one and two applications to the foliage, 10 days apart in July, significantly increased both yield and kernel weight of a group of spring-sown dormoat lines. A third application showed no further improvement in either trait. In another test with this fungicide, the same improvements in yield and kernel weight were duplicated with Garry and Sentinel oats, and increases in percentage of seed protein levels were obtained also.

A barley and oat mixture test showed that in three out of four cultivar combinations crown rust severity was reduced when the ratio of oats to barley was reduced. In addition, the mean kernel weight and percentage of protein of the harvested oat seed was increased as the above ratio was reduced. In the case of barley, a 1:1 ratio of oats to barley gave the highest kernel weight and protein levels.

Cereal morphology and microchemistry

Fluorescence microscopic techniques have been applied to a variety of cereal products in order to evaluate effects of mechanical and digestive processes on important grain constituents. Markers for protein, lipid, carbohydrate, and minor seed reserves are capable of detecting small chemical and structural changes that occur during industrial processing or in the mammalian gut during digestion. An improved milling system has also been developed (with Engineering and Statistical Research Institute personnel), which permits grinding of ceral tissues to subcellular size, consequently allowing improved biochemical analysis of major constituents.

CYTOGENETICS

Wide crosses in cereals

The major genes for crossability of Betzes barley with Chinese Spring wheat are located on chromosomes 5A, 5B, and 5D of Chinese Spring. Complementary gene action is involved, because the presence of single crossability genes does not permit crossability. The genes function by permitting the germination of pollen grain on the stigma while preventing the entry of pollen tubes into the micropyle. The same chromosomes are involved in permitting crossability between *Hordeum bulbosum* L. and Chinese Spring wheat. Thus, attempts are being made to cross with contemporary barley cultivars those wheats that showed good crossability with *H. bulbosum* and that have more agronomic potential than Chinese Spring, the cultivar that has been successfully crossed with barley.

In an effort to produce additional lines of rye in barley, the wild rye species *Secale vavilovii* L. was crossed onto tetraploid Betzes, to give a hybrid with the expected number of 21 chromosomes, 14 from barley and 7 from rye, in most of the cells. Chromosome numbers in root tip cells ranged from 7 to 24, with a mean of 19.7, including many with fragments. Fragmentation and disintegration of chromatin was evidence for instability and consequent elimination of rye chromosomes, as observed in other bybrids between barley and rye. The chromosome numbers in meiotic cells ranged from 14 to 26, with a mean of 18.3. The average metaphase I configuration at meiosis was $0.02^{IV} + 0.3^{III} + 6.68^{II} + 3.92^{I}$, with an average chiasma frequency of 12.9.

Hordeum gene pool

The ORS gene pool has 424 entries of *H. bulbosum* obtained from 133 sites in Spain, Greece, Turkey, Iran, USSR, and The People's Republic of China. Current studies are designed to determine the nature and extent of phenotypic variation, which could have genotypic significance in terms of the crossability of *H. bulbosum* with *H vulgare* L. and other cereals such as wheat. In relation to the geographic distribution and ecological specialization, the chromosome number and morphology, bivalent associations of chromosomes, and crossability patterns among and between types are being studied and analyzed. A diploid population ($2n = 2x = 14$), isolated in southeast Spain, has proved to be highly polymorphic for a number of vegetative characters such as growth type, tiller number, culm and spike length, and bulb

shape and size. The type of variation overlapped with the observed variation in autotetraploid *H. bulbosum* to such an extent that the two ploidy levels cannot be reliably distinguished on the basis of morphology alone, and that chromosome number verification is essential for distinguishability.

Chromosome banding

N-bands were produced on the chromosomes of *Triticum durum* Desf. (AABB), *T. dicoccum* Schrank (AABB), and *T. ventricosum* Ces. (MMDD) from Feulgen preparations. A poorer quality of N-banding was obtained on *Hordeum vulgare* L. Only centric bands were obtained on *Secale cereale* L. and *Bromus inermis* Leysser.

Tissue culture cytology. The chromosome number of 48 plants that had been regenerated from 6-mo-old callus cultures derived from immature embryos of triticale cultivar Welsh ranged from $2n = 36 + 6$ telocentric chromosomes to $2n = 42$. Plants differing in chromosome number were regenerated from the same piece of callus, which indicated that the karyotype was still unstable after 6 mo (six subcultures). Chromosome banding revealed that the majority of telocentric chromosomes were wheat chromosomes. Eighteen plants contained telocentric chromosomes, 8 plants were lacking entire chromosomes, and 15 plants contained deletion or recombinant chromosomes.

***Bromus* cytogenetics**

The chromosomes of three large chromosome species of section Pnigma (*B. benekenii* (Lange) Trimen, *B. pacificus*, and *B. ramosus* Hudson) paired infrequently, if at all, with the chromosomes of some small chromosome species of this section (*B. erectus* Hudson, *B. inermis* Leysser, *B. pumpellianus* Scribner, *B. riparius* Rehm, and *B. variegatus* MB Fl) in interspecific hybrids. The chromosomes of the two groups are highly differentiated from one another, and gene transfer between these groups would appear to be difficult.

Flax

Haploids selected from haploid–diploid twins in the flax cultivar Rocket 4 were used in a haploid × diploid crossing program to transfer the twinning trait into genetic stocks for haploid flax breeding. Results from double crosses in flax between F_2 haploid–diploid twins that were selected from two single crosses, haploid (Rocket) × diploid (Natasja) and haploid (Rocket) × diploid (Dufferin), revealed that the plant height characteristic of the fiber cultivar Natasja, the rust resistance of cultivar Dufferin, and the haploid–diploid twinning frequency and meiotic patterns characteristic of cultivar Rocket 4 were combined in the progeny. There was segregation for the traits among the twins in each F_2 family. Selection is in progress to obtain true breeding lines that are tall, rust-resistant, and have the twinning trait.

ENTOMOLOGY

Population dynamics and pest management

Alfalfa weevil. Ecological life tables showed that the fungus disease and two *Microctonus* parasites acted in concert to further reduce populations of the alfalfa weevil in 1981. Pooled data from three sites in the Quinte area showed that attacks by first brood *M. aethiopoides* Loan during the last week of May reduced egg production by one-third. Triggered by excessive rainfall, epizootics of disease began in early June, destroying 93% of the feeding larvae and 43% of the cocooned stages. In early July, roughly one-fifth of the emerging adults were infested by larvae of *M. colesi* Drea, and during late July and early August an additional 38% was attacked by wasps of the second brood of *M. aethiopoides*. Generation survival to the onset of hibernation averaged 1%, compared with a 10-yr mean of 6%. This points to lower populations for 1982.

Suppression of the fungus disease by foliar applications of captafol (Chevron Chemical Canada Ltd.) proved to be an effective tool in field studies undertaken to assess the competitive fitness of the two parasites. In 1981, maximum oviposition of *M. colesi* occurred after the disease outbreak, and the adults were attracted to areas where weevil larvae had survived the disease. Dissections showed that second brood *M. aethiopoides* readily attacks hosts already parasitized by *M. colesi*, and that in such cases *M. aethiopoides* is the survivor.

A polynomial function has now been developed for predicting biological events in the life history of the weevil. The model is amenable to real-time weather acquisition and offers a practical alternative to models now in use for monitoring insect development in integrated pest management (IPM) programs. During

1981, the Farm Radio Advisory was maintained in eastern Ontario, and a computerized delivery system was initiated in western Ontario, where a field scout used an interactive terminal to obtain daily advisories. The advisories contained data on crop and insect development, together with sampling instructions and advice to pass on to growers when economic populations of the weevil were detected.

Alfalfa blotch leafminer. Life tables for the alfalfa blotch leafminer at three county sites in eastern Ontario showed that survival rates varied from 0.3 to 20%, decreasing in each of its three generations. The main biotic influence was the native damsel bug *Nabis ferus* (L.), which preys on the larvae within the mines. Also important was mortality of feeding larvae because of competition for space within a leaflet, mortality of prepupal larvae from unknown causes following mine evacuation, and mortality of the pupae caused by the exotic parasite *Dacnusa dryas* (Nixon).

There were two generations of *N. ferus* in 1981. Ovarial development in overwintered adults began in late March, and females were gravid by the 1st wk of April. Eggs deposited in alfalfa hatched at mid-May and the nymphs developed through five instars. New adults appeared in early July and began to oviposit in about 10 days. Second generation nymphs appeared in late July, reached peak numbers at mid-August, and transformed to adults at mid-September; these continued to forage for prey in late fall, but ovarial development did not occur. Females collected in September and caged at 23°C laid an average of 145 eggs.

A thermal summation system has been developed for predicting seasonal development of the leafminer in southern Ontario. Based on heat units above 5°C, peak flights in the spring follow the accumulation of 300 degree-days from 1 April. Peak hatch of the eggs occurs at 413 degree-days, peak mining activity at 450 degree-days, and peak evacuation of mines at 500 degree-days. Peak flights in the second and third generations occur at 859 and 1459 degree-days, respectively.

Honey bees

Behavior and physiology. Worker honey bees recognize their own queen and can distinguish her from foreign queens on the basis of individual odors. Recent experiments have indicated that the odors of queens are in part genetically determined and in part acquired from the hive environment. Queen replacement is more successful when the newly introduced queen is genetically related to the colony's old queen.

The total amount of volatile fatty acid varied in the mandibular glands of worker bees of different ages, but the acid ratios did not change and matched those of royal jelly.

Tests of four pollen trap designs showed that strong colonies were adversely affected by some traps, which caused congestion at the hive entrances. This problem increased with temperature and humidity.

The yellow pigments of pollen, which absorb long-wave ultraviolet, serve as visual signals attracting forager bees, but not as phagostimulants for hive bees.

Disease. Colonies killed by American foulbrood disease contained viable spores of *Bacillus larvae* (White) in the extracted honey, melted cappings, wax, and trapped pollen. The thermal conductivity of beeswax was higher in dark, unprocessed wax than in light, refined wax. Oxytetracycline did not interfere with the action of fumagillin, which allows feeding the two antibiotics simultaneously in order to protect colonies from American foulbrood and nosema diseases. A widespread outbreak of American foulbrood was successfully brought under control in 1 yr, by removing from the hives all brood combs with diseased larvae, and by subsequently treating the colonies with oxytetracycline (Terramycin^{R}).

Colonies on fresh comb were successfully inoculated with chalkbrood disease by feeding pollen–sucrose cakes containing 10^{4} spores of *Ascosphaera apis* (Maasen ex Claussen) Olive & Spiltoir. The disease level was reduced by citral vapors. However, if the inoculum was 10^{8} spores, the colonies developed more infection in the presence of citral than without.

FORAGE CROPS

Grasses

Timothy. Emphasis continues to be placed on the development of improved cultivars, with a wide range of maturity, high forage aftermath, and seed yields, and with a higher percentage of digestibility and protein content. Salvo, an early maturing cultivar that is

valuable in mixtures with alfalfa for early cut haylage, was licensed in 1980.

Approximately 200 crosses were made, using highly selected progeny-tested parents for forage and seed yield. These are being advanced to the synthetic-2 generation for testing. A new synthetic form (O-C, high digestibility) of Champ origin was planted in the Ontario provincial trials and will also be entered in the 1982 Quebec trials. Seed was harvested from two new synthetics established in 1980.

Orchardgrass. Particular emphasis was placed on selections of orchardgrass cultivars with a wide range of maturity, high forage and seed yields, and high digestibility and protein content. Crosses of highly selected parent plants, progeny tested for forage and seed, were advanced to the synthetic-2 generation for testing. A new synthetic form of Rideau orchardgrass with higher yield and greater winterhardiness is being tested in the Ontario provincial trials.

Alfalfa

The main objectives in alfalfa breeding have centered on yield, *Phytophthora* root rot (PRR) resistance, and selection for better nitrogen fixation.

Dry matter (DM) yields from replicated trials conducted at Ottawa in 1978–1980 showed that Ot-78/1 produced equal DM yield to Algonquin. However, the new Ottawa selections, Ot-78/1 and Ot-78/2, have better bacterial wilt (BW) resistance ratings than Vernal, and their PRR disease severity index (DSI) scores were low (1.73 and 1.40, respectively). Ot-78/1 has 82% PRR-resistant plants, as compared with Apollo and Trident which have 54 and 72%, respectively. Ot-78/2 has 94% resistant plants; however, its yield potential is less than the check cultivar Algonquin. These two synthetic selections are being tested at various locations in Ontario, along with a third synthetic selection, FAR-14/1.

Pathogenic capabilities of 74 *Phytophthora megasperma* Drechsl. isolates, obtained from soil and plant samples collected from fields in Ontario and western Quebec, were examined. Our data indicate the presence of races or biotypes of *P. megasperma* in relation to pathogenicity. More research is under way to ascertain these findings, which if confirmed will necessitate modifications in the alfalfa breeding strategies for PRR resistance.

In 1980, an alfalfa breeding program to increase N_2 fixation was initiated. Alfalfa cultivars Saranac, Banner, and Thor were initially screened in selection experiments. Tops, roots, and nodules were scored, and dry weight was obtained. Chlorophyll content (CC) was estimated and acetylene reduction (AR) was measured. Considerable variation was observed in all characteristics measured, among individual plants from the three cultivars. Each cultivar was divided into subpopulations for high and low AR, high and low top dry weight, and high and low CC. Another cycle of selection is under way.

Pathology. The potentially significant work on alfalfa pathology was related to the determination of serious pathogens in 12 counties of eastern Ontario. One hundred alfalfa fields, representing about 1% of the total area of production, showed the absence of the wilt pathogen, *Verticillium albo-atrum* Reinke and Berth. *Phytophthora megasperma* Drechsl. (the root rot pathogen) was detected in 9 fields, *Phoma medicaginis* Malbr. Roum. (spring black stem) in 18 fields, and *Colletotrichum trifolii* Bain (anthracnose) in 9 fields. Saprophytic species of *Pythium* and *Fusarium* were prevalent in most fields.

Corn

Breeding. Three new hybrids qualified for licensing in provincial trials: OX679 and OX681 in Manitoba and OX697 in Ontario. Commercial seed production and marketing rights for all of them have been awarded.

A program placing increased emphasis on the development of modified single-cross hybrids was begun with the making of 28 related-line crosses. Hybrids involving these were made in the winter nursery for testing in 1982. Difficulties in economical seed production of recently released, very early maturing, true single-cross hybrids have been reported. The expected modest level of heterosis exhibited by some sister line crosses, which will be used as ear parents, without too great a loss of the generally superior performance of true single crosses, may result in a sufficient increase in seed yield to solve the problem.

Development of equipment permitting the efficient measurement of root strength in large populations has been completed, and it is now in routine use. Development of equipment to measure the compression strength of dried

stalk sections as an indicator of stalk stiffness was begun.

Agronomy. Row mixtures of corn and soybeans yielded less total forage than corn alone. The reduction for one row of soybeans to three rows of corn was less than 1200 kg/ha, or 10%. Reduction in grain yield was larger at 15, 34, and 50% for one, two, or three rows of soybeans. In addition to yield, other factors being considered are quality of forage, fertility requirements, and herbicide effectiveness.

Soybeans

Breeding. The intermediate maturity line AU313(OT80-1) was licensed as Maple Amber for growers in the short-season areas of Canada, with 2400 corn heat units. Maple Amber matures 5 days before Portage, yields 10% more, and has higher seed oil and protein levels. Yields obtained by elite seed growers were as high as 3000 kg/ha, with protein levels significantly above other cultivars.

Nattawa, the first Canadian natto-type cultivar, was licensed and released through SeCan Association. This cultivar has seeds half the standard size and is suitable for the production of the Japanese fermented soy-food, natto. The small-seed characteristic derives from a cross between the cultivated soybean, *Glycine max* (L.) Merrill, and the wild species, *G. soja* Sieb. & Zucc.

Agronomy. Soybeans at six-row spacings were overseeded at right angles with rows at all spacings to produce 35 patterns. No overseeded plot yielded more as a 3-yr mean than plots of one-way rows 18 cm apart. All cross-seeded plots produced taller plants with higher basal pods than one-way plots.

Pathology. A guideline has been suggested for sampling soybean plants infected with *Pseudomonas syringae* pv. *glycinea* Young, Dye, & Wilkie (bacterial blight), in order to estimate disease incidence. From mid-season onward, the distribution of infected plants is likely to be regular, as determined by using three indices of nonrandomness in field plot studies. The shape of sampling path was less important than the sample size in relation to the precision of estimates.

Survey (1981) suggested that both bacterial blight and brown spot (*Septoria glycines* Hemmi.) are prevalent in eastern Ontario.

GENETIC ENGINEERING

Developmental plant physiology

Organogenic callus cultures of *Nicotiana tabacum* L. 'Wisconson 38' were established and investigations on the response of isolated mitochondria to osmotic stress were initiated.

The first phase of a cell-culture project using *Medicago sativa* L. commercial cultivars was begun. Callus and cell suspension cultures of six cultivars, Answer, Armor, Citation, Rambler, Saranac, and Thor, were established. Embryogenesis was observed in the Answer, Citation, and Saranac cell lines. Studies on the isolation, culture, and regeneration of protoplasts were also initiated.

Somatic embryo formation in leaf explants of *Solanum melongena* L. 'Imperial Black Beauty' (eggplant) varied with genotype. About 12% of the seed tested showed a high yield of somatic embryos. Cell suspension cultures with embryogenic capacity were established. Protoplasts isolated from such cultures could be induced to divide and produce cell colonies, from which shoots were regenerated at an efficiency of 5%.

Experimental haploidy

The influence of culture temperature on microspore embryogenesis in anther cultures of *Brassica campestris* L., *B. hirta* Moench, and winter *B. napus* L. was systematically studied. The frequency of haploid embryo development in all three species was stimulated by an initial culture period of 1–3 days at 35°C, prior to maintenance of 25°C. Culture of *B. napus* anthers in liquid medium resulted in a 100% increase in embryo yield, with more than 1000 embryos obtained from 100 cultured anthers. The embryos produced in liquid were more viable than those obtained on agar. Several hundred *B. campestris* and *B. napus* microspore-derived regenerates were shipped to breeders in Guelph and Saskatoon, and also to breeders in England, for field evaluation.

A study of eggplant anther culture revealed that, as in *Brassica*, an initial period of culture at 35°C favored embryogenesis. Five haploid lines have been regenerated from anther-derived embryos and have subsequently been used as a source of haploid cells for mutagenesis experiments.

Somatic cell genetics

Totipotent, embryogenic tissue cultures of *Bromus inermis* L. 'Manchar' were initiated from mature seeds, seedling meristems, and immature male inflorescences. Cultured material produced secondary adventitious embryos, which have been successfully germinated to seedlings on hormone-free medium. Similar cultures have also been initiated from *Zea mays* L. 'A188'.

Liquid suspension cultures of *B. inermis* were established from secondary embryos, from embryogenic organized callus, and from disorganized friable callus to determine procedures for regeneration of plants from single cells.

Conditions of media and growth regulator concentration were defined for the initiation and maintenance of callus cultures of *Lycopersicon esculentum* (L.) Mill 'Ottawa 78' and 'Subarctic Maxi' and the wild relative *L. peruvianum* (L.) Mill. Strong varietal differences in response to growth regulators in the culture medium were demonstrated.

Procedures for the isolation of amino acid analogue resistant mutants have been pursued, using suspension cultured cells of eggplant, a species for which successful tissue-culture procedures have been developed.

Somatic hybridization

Protoplasts of a chlorophyll-deficient strain of *Nicotiana rustica* L. were fused with those of wild-type *N. sylvestris* L. Plants were regenerated from green colonies selected in postfusion protoplast cultures. Cytological, morphological, and isozyme analysis of 15 lines provided evidence that all the regenerates were somatic hybrids. Because of the rapid greening of *N. rustica* protoplasts in vitro, it was concluded that the chlorophyll-deficient strain of this species could be of widespread value for somatic hybridization with other species that normally do not synthesize chlorophyll in vitro.

Molecular genetics

A new research program was initiated, involving the development of methods for artificially transferring isolated genes into plant cells through the use of recombinant DNA and plant cell culture techniques. A fully equipped laboratory was established, and preliminary studies on potential vector systems were done.

ORNAMENTALS

Floriculture

The goals of the floriculture program are to develop energy-saving practices, to select ornamental plant species or cultivars with low temperature tolerance, to work on retardation of plant senescence, to improve labor-saving methods, and to introduce new cultivars.

Flower yields of *Alstroemeria* and the monetary returns in winter were increased by exposing the plants to a 16-h day and 5°C for 6 wk, conditions that simulate, in commercial production, the natural cooling period that occurs during the fall. The Regina types were more tolerant to high temperature that the Orchid types. The gibberellic acid (GA) content of shoots and leaves of *Alstroemeria* was not related to the growing temperature or flowering response.

It was shown that the node was not a reliable estimate of the time of flower initiation of New Guinea *Impatiens*, unless treatment influences on the rate of node production were considered. A quantitative short-day response of flowering at 25°C was confirmed; inhibition of flowering in long photoperiods was not due to photosynthetic influences. In 12-h photoperiods, flowering occurred earliest in a 15°C day–15°C night thermoperiod, but flower bud production was considerably enhanced in a 15°C day–20°C night thermoperiod and was intermediate in 20°C day–15°C night or 20°C day–20°C night thermoperiods.

Streptocarpus nobilis (C. B. Clarke) leaf explants are used to study in vitro the induction of flowering. A medium was developed allowing flower bud induction on 100% of explants from photoperiodically induced leaves. The maximum flowering occurred in medium containing benzyladenine (BA); indoleacetic acid (IAA) inhibited flowering. High KNO_3/high sucrose medium induced vegetative bud development; on low KNO_3/low sucrose medium, only flower buds were formed. On low KNO_3 medium, organogenesis was quantitatively inhibited by increasing levels of sucrose. Explants from leaves of axillary branches were more responsive than those from leaves on the main stem. The uniform in vitro response at a predictable location on the main vein provides a system for studies on flowering.

It was established that a short-day photoperiod (8-h) promoted flowering of *Bouvardia*.

Calceolaria 'Anytime' and *Gerbera* 'Happipot' cultures, as fast-growing pot plants, were investigated and described.

H-NMR measurements indicated that the biophysical and biochemical changes occurring in senescing flowers seem to be related to fast-energy and enthropy changes, resulting in an increase of the cell membrane permeability. Differences were noted between fast-aging flowers versus slow-aging flowers, and flowers treated with antiethylenic compounds (Ag^+, TH6241).

Ethylene-stimulated, cyanide-resistant respiration and senescence processes in plant tissues appear to be related. Inhibitors of the alternative respiratory path, i.e. thiocyanate and 8-hydroxyquinoline, inhibited ethylene production. Disulfiram and 2-thenoyltrifluoracetone also inhibit ethylene production.

Glyphosate, with an active ingredient (a.i.) level of up to 148 g/ha, selectively inhibited growth of Kentucky annual bluegrasses and creeping bentgrass; these responses may be used to control bentgrass growth in turf. L-Phenylalanine and L-tyrosine decreased the glyphosate phytotoxicity.

In vitro methods are being developed to improve the propagation procedures used in nurseries. Explants of M26 *Malus* rootstock multiplied six times after 28 days on Murashige and Skoog (MS) medium supplemented with BA, GA, indolebutyric acid, and phloroglucinol. Sixty-three percent of shoots, excised and transferred to a medium without BA, developed roots after 6 wk. On one-quarter MS medium and 1% sucrose, 97% explants developed roots after 4 wk in culture, but plantlet vigor was decreased. The development of roots in vitro was not necessary to establish plants in soil: shoots from full strength MS medium showed 100% establishment, even though only 30% of the shoots had visible roots.

In the popular annual chrysanthemum show (held since 1912), the display of new cultivars and designs was continued. The permanent tropical plant show, housing some 500 plants, was maintained.

Pathology

Xanthomonas nigromaculans (Takinoto) Dowson f. sp. *zinniae* Hopkins & Dowson, which causes bacterial leaf spot of zinnia, was epidemic in Ontario. It was found on seed from various sources and, therefore, is probably imported on the surface of seeds. Control of the disease by seed treatment is being investigated. *Alternaria zinniae* Pape was also severe on zinnia in several locations; hot water treatments for control are being tested. Both diseases are unreported in Canada.

The extent of damage to *Philodendron* spp., caused by a strain of *Erwinia chrysanthemi* Burkholder et al., was determined. The disease persisted in plants for several months, but produced symptoms only under conditions suitable for bacterial growth. Under most domestic conditions, the symptoms appeared sporadically and never completely destroyed the plants. completely destroyed the plants.

Rhizoctonia solani Kühn was isolated from mature *Ficus benjamina* L. Plants with the fungus indicated that, although *F. benjamina* is susceptible, the disease develops slowly, and necrosis and leaf drop appear under adverse growing conditions only. A strain of *R. solani* from peony caused death of young *F. benjamina* plants in 7 days.

When large quantities of *Trichoderma viride* Pers. ex Fri. were added to soilless mixtures in the presence of casein hydrolysate, the persistence of the fungus was increased, decreasing the incidence of root rot on poinsettia (*Euphorbia pulcherima* Willd), caused by *Pythium aphanidermatum* (Edson) Fitzp. The effect of casein hydrolysate was greatest at pH 4.0–5.0 and 22°C, but growth of poinsettia was poor under these conditions.

Plant breeding

The goal of the program is to improve winterhardiness, flowering, and ornamental features of roses and other ornamental shrubs.

Weigela. A new winter-hardy, freely flowering, attractive dwarf *Weigela* cultivar, Minuet, was released for production. Minuet combines the features of winterhardiness and low stature, seldom found in *Weigela*, and is bushy and well balanced. The only other hardy dwarf cultivar, Purpurea, is rigidly upright. Preliminary studies indicated that height is controlled by several heritable factors. Three-year-old seedlings of Minuet × Purpurea had all low statures. Seedlings of the same age from the cross Minute × Variegata, a nondwarf, showed a wide range of variation in height. Efforts in breeding winter-hardy, continuously and freely flowering bush and climbing roses produced a number of selections with the desired characteristics. Four of these are currently grown at 20 locations across Canada and bordering

states of the United States, to test their adaptability and winter survival.

Nursery research

The main objective of the new nursery research program is to improve woody ornamental performance in the landscape. Work on plant–water and transplanting stresses and mycorrhizal use in the nursery industry has been initiated.

Ornamentals garden

In 1981, 184 fibrous-rooted begonias, *Begonia* × *semperflorens-cultorum* Hort., were planted and evaluated. The top rated cultivars of the green-foliage type were Rosalie and Sheila. Of the bronze-leaved begonias, White Devil, Nubia, and Danica Scarlet rated best. Highest scoring of the 103 zinnia cultivars were Cherry Ruffles, Hobgoblin Mix, and Cherry Ruffles. Forty cultivars of portulaca were evaluated and Sunglow Yellow, Sunglow Orange, Sunglow Orchid, and Sunnyside Cherry were rated best. Dazzle, Regalia Mix, and Canadensis compact Grandiflora were rated the best verbenas in the test.

Dominion arboretum

The extremely severe winter of 1980–1981, with temperatures dropping to –38°C, killed many trees that had survived the last 40 yr. *Fraxinus excelsior* L. and its many cultivars were killed. *Catalpa speciosa* Warder ex Engelm. was killed back to the main branches; two other species, *C. bignonioides* Walt. and *C. hybrida* Hort. ex F. L. Spaeth, were hardly affected. *Quercus robur* L. was badly damaged.

PLANT GENE RESOURCES

Plant gene information

Descriptions for almost 7000 stocks of alfalfa, barley, oat, tomato, and wheat have been obtained to date, with more than 45% of these in 1981. The information on each stock is stored in the respective crop data banks, and computer trait inventories on the five crops are available. Work is under way to extend this activity to other crops.

Conservation

Close to 62 700 seed stocks of various plant species are being preserved under controlled conditions at the Plant Gene Resources of Canada (PGRC) Office. With the addition of new storage space in 1981, the facilities include 54 m^3 at 4°C and 20% relative humidity for medium-term storage, and 145 m^3 at –20°C, using airtight containers, for long-term storage. Seed material stored includes accessions from the Canadian wild oat gene pool (CAV Collection), Canadian accessions already described by plant breeders, Plant Gene Resources accessions introduced by the PGRC Office, the Canadian Hordeum Collection (CHC), the U.S. Department of Agriculture's World Collections of barley, oat, and flax, the California Wheat Collection, the Regina Wheat Collection, and the International Board for Plant Genetic Resources (IBPGR) International millet, oat, barley, and rapeseed collections. Under Canada's participation in the program of the IBPGR for the preservation of international collections of valuable germ plasm, collections of pearl millet, oat, and barley were received from Yemen, Zambia, Botswana, Malawi, Gambia, Sudan, and Mozambic in 1981.

Exchanges

In 1981, activities of the PGRC Office, in connection with exchanges of genetic stocks and cultivars, involved 287 such exchanges with individuals in 37 countries, for a total of almost 3400 accessions.

Newsletter

The PGRC newsletter, which was started in 1976, has a mailing list of 700 individuals, 540 in Canada and 160 in 36 other countries. This semiannual newsletter reports informally on activities and programs in Canada and elsewhere, in connection with plant gene resources.

EXPERIMENTAL FARM KAPUSKASING, ONT.

Cereal management

For two consecutive years, 1980 and 1981, early maturing cultivars from the Northern Research Group (NRG) out of Beaverlodge, Alta., were evaluated with Ontario and Quebec cultivars under the climate of the Great Clay Belt. Twenty-one entries were evaluated in the northern barley trial and 20 entries were evaluated in the regional trial. The average grain yield over a period of 2 yr in the northern barley trial was 5308 kg/ha, whereas

the average for the Ontario and Quebec regional cultivars for the same period was 5256 kg/ha. There was also a slight advantage in the lodging resistance in the northern barley cultivars over the regional cultivars, from 4.0 to 4.4 over the same 2-yr period. The most significant difference in agronomic characteristics was in earliness! Again, the barley cultivars from the NRG matured at an average of 94.3 days during 1980 and 1981 season, whereas the Ontario and Quebec cultivars required an additional 8 days or more to ripen (102.2 days). This difference in number of days to reach maturity becomes significant in marginal areas such as the Great Clay Belt, where the abrupt decrease in sunshine hours limits evapotranspiration.

Among the Ontario and Quebec barley cultivars evaluated, Summit, O.B. 150-29, Sophie, Vanier, Elrose, Bruce, and Peguis were the top-yielding ones. Summit continues to perform well in this area of the province; it has been the top yielder three times in the past 4 yr. Several cultivars in the northern barley trial, such as NRGB80-10, BT-657, BT-655, NRGB80-5, Hankkija 673, and Etu, have shown excellent yield potential, earliness, and good straw strength. These cultivars have been outperforming the recommended varieties from Ontario and Quebec in this area and represent significant progress in developing early cultivars for short-season areas.

Similarly, the three recommended cultivars of oats from Ontario were compared in the same trial with five cultivars from Quebec (Laurent, Alma, Manic, Lamar, and Dorval) over the period 1977–1981. These cultivars from Quebec yielded 13% more than the cultivars recommended for Ontario (Oxford, Elgin, and Sentinel). The Quebec cultivars required 2 days more to reach maturity; however, two of the five entries matured in the same range as the Ontario entries. Two cultivars from Quebec also had the same straw strength or better than Elgin. There was almost no difference in seed size based on the weight per 1000 kernels. Elgin was the lowest yielding cultivar during this period of testing. In the same trial, there were two cultivars from Western Canada, Cascade and Fidler, and a new release from Quebec, Shaw, all of which appear promising after 2 yr of testing.

EXPERIMENTAL FARM THUNDER BAY, ONT.

Tillage management

Initial procedures for this project began in the fall of 1980, by spraying the test site with 2.5 L Round-up (Monsanto). Primary tillage was plowed at an average depth of 10 cm and minimum tillage cultivated at a depth of 6 cm. These were left in this state over the winter period.

In the spring of 1981, primary tillage received disking and harrowing. Minimum tillage received light harrowing, but zero tillage received another spraying with 2.5 L Round-up. Seeding was completed on 22 May 1981, using Glenlea wheat, Oxford oats, and Herta barley as annual crops. Perennial crops were as follows: grasses—Kay orchardgrass, Baylor bromegrass, and Champ timothy; legumes—Ottawa red clover, Leo trefoil, and WL215 alfalfa. Infestations of mainly annual weeds were a major problem on treatments of primary and minimum tillage in all three crops seeded in 1981.

The 1981 cereal crop yields were as follows: Glenlea wheat—primary tillage 3258 kg/ha, minimum tillage 2171 kg/ha, zero tillage 2819 kg/ha; Oxford oats—primary tillage 2384 kg/ha, minimum tillage 3375 kg/ha, zero tillage 3893 kg/ha; Herta barley—primary tillage 3919 kg/ha, minimum tillage 3162 kg/ha, zero tillage 2793 kg/ha.

Yields for legumes were established fairly well, with little significance between tillage treatments. Average yields for legumes were as follows: red clover 2417 kg/ha, trefoil 1492 kg/ha, and alfalfa 2208 kg/ha. Grasses were slower to establish, and average yields were as follows: orchardgrass 1145 kg/ha, bromegrass 1293 kg/ha, and timothy 1613 kg/ha.

In 1982, this project will be repeated with a follow-up spray program, necessary on both primary and minimum tillage treatments.

PUBLICATIONS

Research

Armstrong, K. C. 1981. The evolution of *Bromus inermis* and related species of Bromus sect. Pnigna. Bot. Jahrb. Syst. Pflanzengesch. Pflanzengeogr. 102:427-443.

Armstrong, K. C.; Keller, W. A. 1981. Chromosome pairing in haploids of *Brassica campestris*. Theor. Appl. Genet. 59:49-52.

Boch, R.; Morse, R. A. 1981. Effects of artificial odors and pheromones on queen discrimination by honey bees (*Apis mellifera*). Ann. Entomol. Soc. Am. 74:66-67.

Bolton, A. T. 1981. Specificity among isolates of *Pythium splendens* from geranium, chrysanthemum, and Rieger begonia. Can. J. Plant Pathol. 3:177-179.

Bolton, A. T.; Cordukes, W. E. 1981. Resistance to *Colletotrichum graminicola* in strains of *Poa annua* and reaction of other turfgrasses. Can. J. Plant Pathol. 3:94-96.

Douglas, G. C.; Keller, W. A.; Setterfield, G. 1981. Somatic hybridization between *Nicotiana rustica* L. and *N. tabacum* L. I. Isolation and culture of protoplasts and regeneration of plants from cell cultures of wild-type and chlorophyll-deficient strains. Can. J. Bot. 59:208-219.

Douglas, G. C.; Keller, W. A.; Setterfield, G. 1981. Somatic hybridization between *Nicotiana rustica* L. and *N. tabacum* L. II. Protoplast fusion and selection and regeneration of hybrid plants. Can. J. Bot. 59:220-227.

Douglas, G. C.; Wetter, L. R.; Keller, W. A.; Setterfield, G. 1981. Somatic hybridization between *Nicotiana rustica* and *N. tabacum* L. IV. Analysis of nuclear and chloroplast genome expression in somatic hybrids. Can. J. Bot. 59:1509-1513.

Douglas, G. C.; Wetter, L. R.; Nakamura, C.; Keller, W. A.; Setterfield, G. 1981. Somatic hybridization between *Nicotiana rustica* L. and *N. tabacum* L. III. Biochemical, morphological and cytological analysis of somatic hybrids. Can. J. Bot. 59:228-237.

Erickson, L. R.; Voldeng, H. D.; Beversdorf, W. D. 1981. Early generation selection for protein in *Glycine max* × *G. soja* crosses. Can. J. Plant Sci. 61:901-908.

Faris, M. A.; Baenziger, H.; Terhune, R. P. 1981. Studies on potato leafhopper (*Empoasca fabae*) damage in alfalfa. Can. J. Plant Sci. 61:625-632.

Faris, M. A.; de Arujo, M. R. A.; Lira, M. de A. 1980. Yield stability of forage sorghum in northeastern Brazil. Crop Sci. 21:132-134.

Faris, M. A.; Sabo, F. E. 1981. Effect of *Phytophthora megasperma* on yield and survival of resistant and susceptible alfalfa cultivars. Can. J. Plant Sci. 61:955-960.

Fedak, G.; Armstrong, K. C. 1981. Cytogenetics of trigeneric hybrids between (*Hordeum vulgare* × *T. aestivum*) × *Secale cereale*. Theor. Appl. Genet. 60:215-219.

Fedak, G.; Nakamura, C. 1981. Intergeneric hybrids *Triticum crassum* and *Hordeum vulgare*. Theor. Appl. Genet. 60:349-352.

Fejer, S. O.; Fedak, G. 1981. Yield component advantage in crosses between spring and winter barley with emphasis on reciprocal effects. Z. Pflanzenzuecht. 87:144-152.

Fulcher, R. G.; O'Brien, T. P.; Wong, S. I. 1981. Microchemical detection of niacin, aromatic amine, and phytin reserves in cereal bran. Cereal Chem. 58:130-135.

Gochnauer, T. A. 1981. Distribution of *Bacillus larvae* spores in the environs of colonies infected with American foulbrood disease. Am. Bee J. 121:332-335.

Gochnauer, T. A.; Furgala, B. 1981. Chemotherapy of nosema disease. Further studies on the interaction of fumagillin and the antibacterial agents, sodium sulfathiazole and oxytetracycline. Am. Bee J. 121:253-254.

Gochnauer, T. A.; Margetts, V. J. 1980. Decontaminating effect of ethylene oxide on honeybee larvae previously killed by chalkbrood disease. J. Apic. Res. 19:261-264.

Gochnauer, T. A.; Margetts, V. J. 1981. Emission of volatile sulphide from residues of diseased honeybee larvae. J. Apic. Res. 20:110-114.

Gochnauer, T. A.; Shearer, D. A. 1981. Volatile acids from honeybee larvae infected with *Bacillus larvae* and from a culture of the organism. J. Apic. Res. 20:104-109.

Harcourt, D. G. 1981. A thermal summation model for predicting seasonal occurrence of the alfalfa weevil, *Hypera postica* (Coleoptera: Curculionidae). Can. Entomol. 113:601-605.

Harcourt, D. G.; Guppy, J. C.; MacLeod, D. M.; Tyrrell, D. 1981. Two *Entomophthora* species associated with disease epizootics of the alfalfa weevil, *Hypera postica* (Coleoptera: Curculionidae), in Ontario. Great Lakes Entomol. 14:55.

Hergert, G. B.; Voldeng, H. D. 1981. A high capacity soybean plot seeder. Can. J. Plant Sci. 61:1013-1016.

Jackson, H. R.; Burrows, V. D.; Wallen, V. R. 1981. Notes on observations and factors affecting dormoat emergence and growth demonstrated by sequential aerial photograph. Can. J. Plant Sci. 61:459-462.

Keller, W. A.; Armstrong, K. C. 1981. Dihaploid plant production by anther culture in autotetraploid marrowstem kale (*Brassica oleracea* L. var. *acephala* D.C.). Can. J. Genet. Cytol. 23:259-265.

Nakamura, C.; Keller, W. A.; Fedak, G. 1981. *In vitro* propagation and chromosome doubling of a *Triticum crassum* × *Hordeum vulgare* intergeneric hybrid. Theor. Appl. Genet. 60:89-96.

Sampson, D. R.; Fulcher, R. G. 1981. Gordon soft white winter wheat. Can. J. Plant Sci. 61:455-457.

Svejda, F. 1981. Minuet weigela. Can. J. Plant Sci. 62:249-250.

Miscellaneous

Bolton, A. T. 1981. Major diseases in ornamental plants. Les floralies internationales de Montréal. Colloq. Sci. No. 6. Protection des végétaux. pp. 89-105.

Burrows, V. D. 1981. Use of genetic variation to breed oats more useful for feed, food and processing. Cereal Foods World 26:493.

Cole, T. J. 1981. Geranium trials—Ottawa 1980. Canadex 28134.

Cole, T. J. 1981. Growing trees in Canadian gardens. Agric. Can. Publ. 1722.

Cole, T. J. 1981. Trials of flowering annuals 1976-1980. Agric. Can. Tech. Bull. 114 pp.

Faris, M. A. 1980. Elements of integrated control of sorghum pests. Chapter 9. Bird pests of grain sorghum FAO. 159 pp.

Faris, M. A.; Baenziger, H. 1981. Progress report on improving alfalfa resistance to phytophthora root rot by breeding. Forage Notes 26:13-18.

Faris, M. A.; Sabo, F. E. 1981. Progress report on pathogenicity differential studies of 74 *Phytophthora megasperma* Drechsler isolates from alfalfa. Forage Notes 26:19-22.

Faris, M. A.; Sirois, C.; Macdowall, F. D. H. 1981. Progress report on nitrogen fixation improvement in alfalfa by breeding. Forage Notes 26:23-30.

Fedak, G.; Nakamura, C.; Keller, W. A. 1981. Intergeneric hybrids between *T. crassum* and *H. vulgare* and their *in vitro* regeneration. Genetics 97:35.

Fulcher, R. G. 1981. The microchemical organization of the groat. Cereal Foods World 26:493.

Harcourt, D. G. 2981. The alfalfa weevil today. Can. Agric. 26(3):24-25.

Jordan, W. A.; Veira, D. M.; Proulx, J.; Guillemette, L.; Corriveau, O. 1981. Grain production in northern Ontario clay belt. Canadex 110.

Loiselle, R. 1981. Canadian Plant Gene Resources Inventory/Inventaire canadien des ressources génétiques végétales. Accessions PGR2409-PGR4468. Received in 1977–78 by the Central Office for the Plant Gene Resources of Canada/Reçues en 1977–78 par le Bureau central des ressources phytogénétiques du Canada, Ottawa Research Station, Research Branch, Agriculture Canada. Report/Rapport PGRC-81-1. 114 pp.

Parups, E. V. 1981. Perspectives de development pour l'industrie canadienne de la floriculture. Les floralies internationales de Montréal. Colloq. Sci. No. 1. Floriculture. pp. 519-548.

Poon, H. H.; Altosaar, I.; Fulcher, R. G. 1981. Mineral distribution in rapeseed. Cereal Foods World 26:520.

Sampson, D. R. 1981. Gordon soft white winter wheat. Canadex 11233.

Simmonds, J. A. 1981. "In vitro" flower bud production on leaf explants of *Streptocarpus nobilis*. Plant Physiol. 67:27.

Simmonds, J. A. 1981. Searching for the key to flowering. Can. Agric. 26(3):8-10.

Svejda, F. 1981. Jens Munk rose. Canadex 28333.

Svejda, F. 1981. John Franklin rose. Canadex 28333.

Svejda, F. 1981. Martin Frobisher rose. Canadex 28333.

Veira, D. M.; Jordan, W. A.; Proulx, J. 1981. Affouragement d'été des bouvillons Holstein dans le nord de l'Ontario. Canadex 41050.

Warren, F. S. 1981. Combinations of corn and soybeans for forage. Forage Notes 25:33.

Warren, F. S. 1981. Forage sorghum production. Forage Notes 25:38-39.

Research Station
Vineland Station, Ontario

PROFESSIONAL STAFF

D. R. MENZIES, B.S.A., M.Sc., Ph.D.	Director
E. PIIL	Administrative Officer
N. GIBSON-MACDONALD,[1] B.A., M.A., M.L.S.	Librarian

Entomology

A. B. STEVENSON, B.Sc. (Agr.), Ph.D.	Section Head; Vegetable pest management
A. B. BROADBENT,[2] B.Sc., M.Sc., Ph.D.	Ornamental entomology
E. A. C. HAGLEY, B.Sc. (Agr.), M.Sc., Ph.D.	Fruit pest management
D. H. C. HERNE, B.A., M.S.A., Ph.D.	Acarology
D. J. PREE, B.S.A., M.Sc., Ph.D.	Toxicology
C. M. SIMPSON	Pesticide evaluation
R. J. M. TRIMBLE, B.Sc., M.Sc., Ph.D.	Bioclimatology

Nematology, Chemistry, and Engineering

J. W. POTTER, B.S.A., M.S.A., Ph.D.	Section Head; Nematode ecology and chemical control
M. CHIBA, B.Sc., D.Sc.	Residue chemistry
T. H. A. OLTHOF, Ing., B.Sc. (Agr.), Ph.D.	Host–parasite relations
J. L. TOWNSHEND, B.Sc., M.Sc., D.I.C.	Nematode ecology

Plant Pathology

W. R. ALLEN, B.A., Ph.D.	Section Head; Fruit virology
J. NORTHOVER, B.Sc., Ph.D., D.I.C.	Fruit mycology
A. A. REYES, B.S.A., M.S.A., Ph.D.	Vegetable mycology

Smithfield Experimental Farm, Trenton, Ont.

S. R. MILLER, B.Sc., M.Sc., Ph.D.	Superintendent; Pomology
W. P. MOHR, B.S.A., M.S.A., Ph.D.	Food processing

N. J. PARKS, B.Sc.	Vegetable management
J. WARNER,[3] B.Sc., M.Sc.	Pomology

Departures

W. G. KEMP, B.A., M.A. Retired September 1981	Vegetable virology
P. W. JOHNSON, B.S.A., M.Sc., Ph.D. Transferred to Delhi Research Station, September 1981	Chemical control
E. N. A. MCMILLAN Transferred to Department of Fisheries and Oceans, February 1981	Administrative Officer

EXTENSION SERVICES[4]

D. RIDGWAY	Fruit and vegetable crops

[1]Seconded from Libraries Division, Finance and Administration Branch.
[2]Appointed 28 September 1981.
[3]Appointed 1 May 1981.
[4]Ontario Ministry of Agriculture and Food, Trenton, Ont.

INTRODUCTION

The Vineland Research Station serves the horticultural industry with a broad program of crop protection research. The multidisciplinary, mission-oriented program includes the application of entomology, acarology, virology, mycology, nematology, residue chemistry, and engineering to a variety of crops, ranging from tree fruits, grapes, small fruits, and vegetables to ornamentals, forage crops, and tobacco. The Smithfield Experimental Farm, located west of Trenton, is administratively linked to this Station and carries on horticultural production and processing research, as well as pest control research programs in cooperation with Vineland.

A number of changes have occurred in the professional staff at Vineland in the past year. Dr. D. R. Menzies was appointed Director of the Research Station following the retirement of Dr. A. J. McGinnis. Mr. W. G. Kemp also retired after 34 yr of service. Dr. A. B. Broadbent, entomologist, was appointed to the new ornamental research program.

This report summarizes some of the research results from the Station in 1981; more detailed information can be obtained from the publications listed at the end of the report. For more information on these or other research projects, or for copies of this report, please write to the Director, Research Station, Research Branch, Agriculture Canada, Vineland Station, Ont. L0R 2E0.

D. R. Menzies
Director

INSECTS AND MITES

Integrated pest management (IPM)

Pest management (manipulation of natural enemies). The toxicity of several insecticides used for control of apple pests to *Apanteles ornigis* Weed, the major parasite of the spotted tentiform leafminer, *Phyllonorycter blancardella* (Fabricius), was determined. Permethrin was found to be 19× more toxic to the leafminer than to *A. ornigis*. Field studies were initiated to determine the lowest concentration of permethrin, applied pre-bloom, required to establish leafminer populations that would result in minimum foliage damage and also support high levels of parasitism. Also, studies of the host–parasite relationship were commenced and preliminary results indicate that *A. ornigis* preferentially attacks the sap-feeding larval instars of *P. blancardella*. Releases of adult parasites in the field will be timed to coincide with peak occurrence of these stages.

Pest management in peach orchards. Populations of the tarnished plant bug (TPB) were found on weeds (primarily chickweed) in and around orchards in the Niagara peninsula. Where suitable alternate hosts were not available, adult TPB moved to peaches. Oak bugs were a problem where large oak trees were in the vicinity of a peach orchard, and although removal of the oaks reduced the level of damage, larvae could drift up to 400 m to cause injury.

Management of carrot insects. The occurrence of carrot weevil, *Listronotus oregonensis* (LeConte), was monitored in carrot fields in the Holland Marsh by using carrot root sections to detect oviposition before the new carrot crop reached a susceptible stage of growth. This was an effective method to determine the need to spray.

Aster (sixspotted) leafhoppers, *Macrosteles fascifrons* (Stål), were monitored on sticky traps, supplemented by periodic D-Vac collections, in insecticide-free plots of carrot, lettuce, and celery or in commercial fields of carrots, or in both situations, at Bradford, Jordan, and Port Colborne. Several peaks of activity were identified; monitoring of these crops should be helpful in decision making for spraying.

Control of the carrot rust fly. Seed furrow applications of chlorfenvinphos (Birlane 3G) and isofenphos (Amaze 20G), both at 2.2 kg/ha, reduced the percentage of carrots infested with carrot rust fly (CRF), *Psila rosae* (Fabricius), by 97 and 92%, respectively, whereas carbofuran (Furadan 10G), the material currently recommended for CRF control, did not reduce damage significantly. Drenches of chlorfenvinphos (Birlane 40E)

and isofenphos (Amaze 60E), at an active ingredient (a.i.) level of 1.1 kg/ha, both reduced damage by nearly 90% when applied at the time when flies first appeared in the crop (2 June), but not when applied 3 wk later. The effectiveness of monitoring adult activity and applying a drench only when necessary suggests an alternative to the routine use of carbofuran at seeding.

Chlorfenvinphos (Birlane 10G) residues of 11.5 and 16.4 mg/kg were measured in soil of the Holland Marsh carrot fields 2 wk after treatment in May, with that chemical, at a.i. rates of 0.6 and 0.9 g/m^2, respectively. These values declined sharply to less than 1 mg/kg by harvest time in September. There was little sign of movement of chlorfenvinphos in soil; these results present some question about the use of three-row seeders in the Holland Marsh. Because the pesticide is distributed to the two outside rows of seed only, protection may not be provided to the center row.

Ecology

The timing of diapause termination and the thermal characteristics of post-diapause development were compared in six Ontario populations of the spotted tentiform leafminer, *Phyllonorycter blancardella*. The populations studied were from the major apple-growing areas, which are located in four climatically different zones. Pupae of all populations collected in the fall and stored under simulated overwintering conditions had terminated diapause by the end of January. Pupae overwintering under natural conditions had also terminated diapause by this time. Significant population differences occurred in the post-diapause developmental threshold and thermal constant. Simulation of post-diapause development and emergence of the six populations using the 1981 temperature records from one location resulted in a 9-day difference between the earliest and latest mean emergence times. The implications of these results for pest management are being explored.

Chemical control

Evaluation of new acaricides. The acaricides BAY SLJ 0312 (Mobay Chem. Corp.), fenpropathrin (WL 41706, Shell Canada Ltd.), amitraz (Baam, Tuco Products Co.), and UC 55248 (Union Carbide Agr. Prod.) were tested in heavily infested orchards at both Vineland and Smithfield. The materials gave good to satisfactory control of mixed populations of European red mite and twospotted spider mite. There was an indication that European red mites in the Smithfield orchard were partially resistant to the registered acaricides cyhexatin, fenbutatin oxide, and dicofol.

Survey of European red mite resistance to cyhexatin in Ontario orchards. In 16 of 19 apple orchards, representing five Ontario regions, low levels of resistance by the European red mite to cyhexatin (Plictran) acaricide was confirmed by laboratory tests. In three orchards the residual effectiveness of cyhexatin was reduced enough to require the growers concerned to apply an additional spray to achieve mite control. However, in the majority of orchards surveyed resistance levels were less than twofold, and mite control was possible with one application.

Insecticide evaluation. An extensive insecticide testing program was conducted to evaluate the efficacy of chemicals and application methods against San José scale, *Quadraspidiotus perniciosus* (Comstock); pear rust mite, *Epitrimerus pyri* (Nalepa); pear psylla, *Psylla pyricola* (Foerster); oriental fruit moth, *Grapholitha molesta* (Busck); tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois); lesser peachtree borer, *Synanthedon pictipes* (Grote & Robinson); and *Chrysopa oculata* Say.

NEMATOLOGY AND CHEMISTRY

Host–parasite relationships

Effects of heavy metals and root-knot nematode on celery grown on organic soil. A field plot experiment to study the interactive effects of heavy metals and the root-knot nematode, *Meloidogyne hapla*, on celery was conducted on a metal-contaminated organic soil farm. Metal contamination was principally from nickel (7500 mg/kg), copper (825 mg/kg), and cobalt (110 mg/kg); normal background amounts of these metals in uncontaminated soil are 55, 30, and 8 mg/kg, respectively. Nematodes alone caused an average 12% reduction in celery shoot weight, whereas heavy metals alone reduced celery shoot weight by 79%. The combined effect of nematodes and heavy metals was an 86% shoot weight reduction. Injury symptoms on the plants in heavy-metal soil were stunting, cupping of leaves, and interveinal chlorosis

and necrosis; these were attributed to nickel. The roots of nematode-inoculated plants from heavy-metal soil had significantly more nematode galls than the roots of inoculated plants from control soil, indicating that heavy metals predisposed celery to greater attack by root-knot nematodes.

Response of apricot seedlines to root-lesion nematode. Fourteen seedlines of apricots were grown for 14 wk in the greenhouse in soil infested with an average of 3200 root-lesion nematodes, *Pratylenchus penetrans*, per kilogram of soil. Overall, nematodes reduced plant height at midseason and at season's end by 13 and 10%, respectively. Dry weights of top and roots were suppressed by 4 and 15%, respectively. It appears that apricots are tolerant of the root-lesion nematode; final nematode population densities showed them to be a poor host for this nematode.

Forages

Relationship between nematode inoculum density and alfalfa seedling stand. Alfalfa seedling stands were not affected by *Pratylenchus crenatus, P. neglectus, P. penetrans,* and *Meloidogyne hapla* in a controlled environment with a 17°C day and a 14°C night temperature. However, fresh weight of foliage and roots declined as the inoculum density increased. Nodulation per gram of fresh root was stimulated by the nematode species and increased as the inoculum density increased. In the presence of the more pathogenic *P. penetrans* and *M. hapla*, only 250 nematodes in 50 g of soil were required to stimulate maximum nodulation, whereas in the presence of the less pathogenic *P. crenatus* and *P. neglectus*, 700–1000 nematodes per 50 g of soil were required.

Ecology

Anhydrobiosis in Pratylenchus penetrans. Anhydrobiosis in *P. penetrans* enhanced the nematode's capacity to survive in a cold environment, but not at high temperatures. The reproductive capacity of *P. penetrans* was not affected by anhydrobiosis. *Pratylenchus penetrans* that had been in an anhydrobiotic state for 207 days in a slow-dried Vineland silt loam increased in celery from 3 per gram of root at 1 wk to more than 1000 per gram at 21 wk. This increase in numbers of nematodes was comparable to that in the controls.

Control

Increase in marketable yield of potatoes due to chemical control of the root-lesion nematode. Basamid, Vorlex, and Telone II B were applied broadcast on 27 April at rates of 500 kg/ha, 90 L/ha, and 100 L/ha, respectively. Potatoes (cultivar Norchips) were planted into the treated plots on 5 April and Temik 10G was applied as a fourth treatment at planting. The untreated control yielded 15% less marketable tubers (>44.5 mm in diameter) than did the Vorlex, Telone II B, and Temik treatments. Although Basamid gave the best nematode control, the marketable yield of tubers from this treatment was only 78%, probably because of phytotoxicity in the early stages of growth.

Fate of oxamyl in peach. A high-performance liquid chromatographic (HPLC) method was developed to determine the residues of oxamyl and its corresponding oxime (one of the major degradation compounds) in peach seeds, seedlings, and soil with either no cleanup or only a simplified one; the minimum detectable limit is 0.1 mg/kg for oxamyl and 0.05 mg/kg for oxime. Relatively high concentrations of oxamyl (4.8 and 2.7 mg/kg) were found in peach leaves grown from oxamyl-treated seeds 2 and 3 wk after sowing, respectively. As concentrations of oxamyl residues in soil, clay pots, and leaves decreased, concentrations of oxime increased in all the samples.

PLANT DISEASES

Fruit crops

Nematode transmission of peach rosette mosaic virus. Adult females and larvae of the newly identified nematode *Longidorus diadecturus* Eveleigh & Allen, 1982, collected near peach trees infected with peach rosette mosaic virus (PRMV), transmitted the virus directly to peach, grape, and cucumber. Larvae were the more efficient vectors. Virus transmission to cucumber was reduced when nematodes were held in soil extracts longer than 3 h before transfer to roots. *L. diadecturus* is considered to be the primary vector of PRMV in Ontario peach orchards. This is the first report to incriminate a *Longidorus* species as a natural vector of a virus that is indigenous to North America.

Grape cultivar susceptibility to tomato ringspot virus. A total of 40 rootstocks and grape cultivars were chip-bud inoculated with an Ontario isolate of tomato ringspot virus (TRSV). Virus was recovered only from the hyorids Chelois, DeChaunac, Siegfried Rebe, Ventura, and Vincent, suggesting that many varieties may have high resistance or immunity to the virus.

Incidence and distribution of the tomato ringspot virus disease in vineyards. Of 57 DeChaunac vineyards (205 ha) surveyed in 1975 and 1981, the number with virus infections increased from 28.1 to 49.1%. The percentage of infected vines in individual vineyards was 0.01–5.6% (mean 0.56%) in 1975 and 0.01–5.9% (mean 1.10%) in 1981. Data indicated both random new infections and infections spead from previously diseased vines. The TRSV disease was also found in 1 out of 5 Baco Noir vineyards, 3 out of 32 Chelois, 3 out of 15 Ventura, and 1 out of 14 Vincent. Virus has not yet been detected in five young Siegfried Rebe vineyards.

Inactivation of tobacco mosaic virus in soil by drying. Soil naturally and artificially infested with tobacco mosaic virus (TMV) was dried by airing, freezing, and freeze-drying. All treatments reduced virus infectivity to a degree related directly to drying rate. Inactivation was slightly greater in drier soils. Analyses by bioassay, spectrophotometry, polyacrylamide gel electrophoresis, T_m in sodium dodecyl sulfate, sedimentation rate, buoyant density, and electron microscopy revealed that the irreversible inactivation was associated with breakage of the RNA molecule and bond disruptions in the protein coat, but not with losses of RNA or protein from the virus. Forces associated with the evaporative process appear responsible for the inactivation of TMV.

Ecology

Botrytis bunch rot of grapes. Botrytis cinerea was the principal fungus causing bunch rot of Chardonnay, Seyval, and Aurore grapes. Fungicide programs of four or five applications, commenced after bloom, were effective against infections of dead tissue and uninjured berries but were much less effective for the protection of cultivars with berries prone to splitting.

Control

Fungicide resistance of fruit pathogens. A method involving a water agar medium, amended with benomyl at 0.5 μg/mL, was developed to test for benzimidazole resistance in *Venturia inaequalis* (apple scab fungus). Resistance was identified in 13 additional orchards this year, bringing to 17 the number of apple orchards in Ontario where Benlate or Easout would be ineffective against apple scab. Resistance to Cyprex had previously developed in several apple-growing regions. This has reduced the number of available effective fungicide groups to three.

Benzimidazole-resistant *B. cinerea* has been identified in nine widely distributed vineyards on the Niagara peninsula; therefore, benzimidazole fungicides will not be recommended for the control of *Botrytis* bunch rot of grapes. The dicarboximide fungicides Rovral and Ronilan are very effective against *Botrytis* infection in some grape cultivars but are not registered for use on edible crops.

Vegetable crops

The effect of antagonistic microorganisms on the virulence of Pythium ultimum on peas. Three of nine antagonists studied reduced the virulence of *Pythium ultimum* Trow from severe to moderate levels on Little Marvel pea (*Pisum sativum* L.) plants grown in the *Pythium*-infested soil at 22°C for 4 wk. The suppressive antagonists were *Gliocladium catenulatum* Gilm. & Abbott, *G. virens* Miller, Giddens & Foster, and *Trichoderma hamatum* (Bon.) Bain. Numerous oospores of *P. ultimum* were observed only in the severely infected root tissues of peas. None of the antagonists caused disease on peas.

CONTRACT RESEARCH

Energy conservation

Product drying. Bentonite can be used for effectively drying corn, wheat, oats, barley, and peas in a ratio of 1:1 or 2:1 (initial mass of grain to initial mass of bentonite), depending on the initial moisture contents of both the grain and the bentonite. Storing grain in bentonite seemed to inhibit the growth and spread of insects in the grain.

Zeolite heat storage for solar grain drying. A computer model was developed that accurately described the performance of a zeolite

grain-drying system. The principle of such a system was shown to be feasible. It was suggested that such a major energy-storage facility could also be used for animal shelter heating, process water heating, and greenhouse space heating.

SMITHFIELD EXPERIMENTAL FARM

Fruit and vegetables

Hardiness of fruit trees during 1980–1981. A temperature drop of greater than 1°C/h in late December followed by record lows of −37°C in early January resulted in severe winter damage to fruit trees in central and eastern Ontario. With apples, Rhode Island Greening, Northern Spy, and Delicious showed the most severe bud and tree damage. McIntosh trees bore a heavy crop in 1980, predisposing them to winter injury. No consistant differences in fruit spur hardiness were observed among McIntosh strains, although Delicious spur types were more severly damaged than nonspur types.

Flemish Beauty pears were the only cultivar to produce a significant crop in 1981. Trees of Clapp Favorite and Anjou survived but bore no crop. Extensive wood damage occurred in Bosc, Bartlett, and French Bartlett trees.

Italian and Stanley prune, Damson, Burbank, Iroquois, and V33028 plums were rated the most hardy but bore no crop. Intermediate in hardiness were Verity, Valor, Shiro, Bluefree, California Blue, and Grand Duke. Early Golden, Methley, Santa Rosa, and Vision trees were killed by the cold temperatures.

Electron microprobe and X-ray fluorescence analysis of fruit and vegetables. Electron microprobe and X-ray fluorescence techniques were used to follow the uptake and movement of Ca and Cl ions into apples after dipping them in solutions of $CaCl_2$. The elemental gradients found in potato tubers showing the physiological disorder hollow heart were studied. The concentration of various elements in potatoes grown under stress indicated that during the early stages of development of this physiological disorder, nutrient imbalances occur that may cause localized toxicity during stages of rapid cell expansion of the tubers.

Control of cauliflower development. Exposure of cauliflower plants to temperatures of 8–10°C for 2 wk prior to transplanting into the greenhouse or field reduced variation of head size at harvest. Following the temperature treatment, 58 and 83% of the crops of White Top and White Summer, respectively, were harvested at one date. Among comparable untreated plants, 19 and 33% were harvested at one date. Cold treatment delayed the harvest but this may be overcome by adjusting the planting dates.

Weed control in cauliflower. Various herbicides were evaluated on direct-seeded and transplanted cauliflower. Alachlor preplant either alone or combined with dacthal or tillam gave good weed control for the season. The cauliflower plants were not as vigorous as those in hand-weeded plots.

Direct seeding into an undisturbed seedbed to which paraquat or paraquat plus chlorthal dimethyl were applied gave excellent weed control with no apparent injury to the cauliflower. Weeds were allowed to reach approximately 10 cm in height (3 wk after cultivation) before treatments were applied. Heavy clay soils were not conducive to good plant establishment.

Tomato breeding and evaluation. Of 20 varieties and advanced lines evaluated, Earlibright, Earlirouge, TH-318, and Floramerica showed promise as early fresh-market cultivars. Yields up to 47 t/ha were obtained between 5 and 27 August with Earlibright. Fruit size with Earlibright and TH-318 is smaller than the industry would like to see.

Of 20 lines grown in the cooperative hand-picked coordinated trial, the most interesting were ST-50, TH-318, and ST-54. ST-50 shows sufficient promise to be named in 1982. In the machine harvest trial, ST-41, Ont. 7616B, and H2653 warrant further testing under eastern Ontario conditions for the whole-pack processing industry. These selections combine small size, firmness, uniform ripening, and small core required for machine harvest.

PUBLICATIONS

Research

Allen, W. R. 1981. Dissemination of tobacco mosaic virus from soil to leaves under glasshouse conditions. Can. J. Plant Pathol. 3:163-68.

Bostanian, N. J.; Herne, D. H. C. 1980. A rapid method of collecting arthropods from deciduous fruit trees. J. Econ. Entomol. 73:832-833.

Chiba, M. 1981. A rapid colorimetric method for analysis of carbaryl spray deposits on fruit tree foliage. J. Agric. Food Chem. 29:118-121.

Chiba, M.; Veres, D. F. 1981. Fate of benomyl and its degradation compound methyl 2-benzimidazole carbamate on apple foliage. J. Agric. Food Chem. 29:588-590.

Fisher, R. W.; Menzies, D. R.; Sutton, J. C.; Stevenson, A. B. 1981. Comparative efficacy of a hydraulic boom and compressed-air boom sprayer for spray coverage and control of leafhoppers and blight in carrots. Proc. Entomol. Soc. Ont. 111:2-6.

Hagley, E. A. C.; Chiba, M. 1980. Efficacy of phosmet and azinphosmethyl for control of major insect pests of apple in Ontario. Can. Entomol. 112:1075-1083.

Hagley, E. A. C.; Pree, D. J.; Simpson, C. M.; Hikichi, A. 1981. Toxicity of insecticides to parasites of the spotted tentiform leafminer (Lepidoptera: Gracillariidae). Can. Entomol. 113:899-906.

Heeney, H. B.; Warren, V.; Khan, S. U. 1981. Effects of annual repeat applications of simazine, diuron, terbacil and dichlobenil in a mature apple orchard. Can. J. Plant Sci. 61:325-329.

Heeney, H. B.; Warren, V.; Khan, S. U. 1981. Effects of a rotation of simazine, terbacil, and dichlobenil in a mature apple orchard. Can. J. Plant Sci. 61:407-411.

Herne, D. C.; Bond, E. J. 1981. Control by fumigants of winter eggs of European red mite, *Panonychus ulmi* (Koch) on harvested apples. Can. Entomol. 113:121-126.

Inculet, I. I.; Castle, G. S. P.; Menzies, D. R.; Frank, R. 1981. Deposition studies with a novel form of electrostatic crop sprayer. J. Electrostat. 10:65-72.

Lister, R. M.; Allen, W. R.; Gonsalves, D.; Gotlieb, A. R.; Powell, C. A.; Stouffer, R. F. 1980. Detection of tomato ringspot virus in apple and peach by ELISA. Acta Phytopathol. Acad. Sci. Hung. 15:47-55.

Lougheed, E. C.; Miller, S. R.; Ripley, B. D.; Cline, R. A. 1981. Electrical impedance of daminozide- and calcium-treated McIntosh apples. Experientia 37:835-836.

Lund, C. T.; Herne, D. C. 1981. Relationships between degree-days and computer simulated events within a population of the European red mite. Proc. Entomol. Soc. Ont. 111:33-37.

Menzies, D. R.; Pree, D. J.; Fisher, R. W. 1980. Role of pesticide and dye concentrations in the visual assessment of pesticide deposits as related to Oriental fruit moth control. J. Econ. Entomol. 73:617-619.

Pree, D. J.; Menzies, D. R.; Fisher, R. W. 1981. Effects of rainfall on persistence of phosmet residues on peach: implications for integrated pest management programs. J. Econ. Entomol. 74:535-538.

Ripley, B. C.; Lougheed, E. C.; Miller, S. R. 1979. Daminozide residues on orchard treated apples. J. Agric. Food Chem. 27:1389-1391.

Stevenson, A. B. 1981. Carrot rust fly: Monitoring adults to determine whether to apply insecticides. J. Econ. Entomol. 74:54-57.

Stevenson, A. B. 1981. Development of the carrot rust fly, *Psila rosae* (Diptera: Psilidae), relative to temperature in the laboratory. Can. Entomol. 113:569-574.

Townshend, J. L.; Stobbs, L. 1981. Histopathology and histochemistry of lesions caused by *Pratylenchus penetrans* in roots of forage legumes. Can. J. Plant Pathol. 3:123-128.

Trimble, R. M.; Wellington, W. G. 1980. Oviposition stimulant associated with fourth-instar larvae of *Aedes togoi* (Diptera: Culicidae). J. Med. Entomol. 17:509-514.

Voisey, P. W.; Kloek, M.; Mohr, W. P. 1980. A method for recording the amplitude of force fluctuations during texture tests. J. Texture Stud. 11:395-400.

Miscellaneous

Heeney, H. B. 1981. Apple rootstock studies. Agric. Can., Smithfield Experimental Farm Tech. Bull. No. 3.

Heeney, H. B. 1981. New apple cultivars and advanced selections at the Smithfield Experimental Farm. Agric. Can., Smithfield Experimental Farm Tech. Bull. No. 2.

Johnson, P. W. 1981. Soil fumigants (revision). Agdex 81-037.

Johnson, P. W.; Potter, J. W. 1981. Soil and root sampling for nematode analysis. Agdex 81-040.

Johnson, P. W.; Potter, J. W. 1981. Nematode control—Guidelines for the application of soil fumigants. Agdex 81-049.

Kloek, M.; Mohr, W. P. 1980. Tomato juice graininess measurements. Agric. Can., Eng. Stat. Res. Inst. Rep. No. I-228.

Kloek, M.; Mohr, W. P. 1981. Supplementary data for the evaluation of tomato juice graininess using the back extrusion method. Agric. Can., Eng. Stat. Res. Inst. Rep. No. I-316.

Mohr, W. P. 1981. Tomatoes for puree or paste: studies on solids content and consistency. Agric. Can., Smithfield Experimental Farm Tech. Bull. No. 4.

Stevenson, A. B. 1981. Carrot insects. Ont. Minist. Agric. Food, Fact Sheet 81.007.

WESTERN REGION
RÉGION DE L'OUEST

Dr. J. E. Andrews

Dr. W. N. MacNaughton

Dr. D. M. Bowden

Mr. H. C. Korven

Mr. I. M. Wood

Mr. J. J. McConnell

EXECUTIVE OF THE WESTERN REGION
L'EXÉCUTIF DE LA RÉGION DE L'OUEST

Director General
Directeur général

J. E. ANDREWS, B.S.A., M.Sc., Ph.D.

Associate Director General
Directeur général adjoint

W. N. MACNAUGHTON, B.Sc., M.Sc., Ph.D.
Seconded from Lethbridge Research Station
Détaché de la station de recherche de Lethbridge

Program Specialist
Spécialiste en programmes

D. M. BOWDEN, B.S.A., M.S.A., Ph.D.

Contracts Specialist
Spécialiste en contrats

H. C. KORVEN, B.E., M.Sc.

Chief, Administration
Chef, administration

P. B. GRIFFITH

Manager, Communications and Public Affairs
Gérant, Communications et affaires publiques

J. J. MCCONNELL, B.S.A., M.A.
Seconded from Communications Branch, Ottawa
Détaché de la Direction générale des communications (Ottawa)

PREFACE

The Western Region, with headquarters in Saskatoon, consists of 15 research stations, four experimental farms, and eight substations. These research establishments serve the agricultural community throughout the Prairie Provinces and British Columbia. In 1981 the Region managed a budget of $48 million and employed approximately 355 professionals and 870 subprofessionals in carrying out its research programs. Highlights of some achievements in the Region in 1981 follow.

Irrigation was shown to improve certain Solonetzic soils by reducing salt levels in the plant root zone, residual phosphorus from a single large application to increase cereal and oilseed yields for at least 8 yr, and the adequacy of potassium levels in the soil to influence productivity of forages.

Cultivars licensed were Ketepwa and Leader hard red spring wheats with sawfly resistance and low α-amylase content, Tobin canola with white rust resistance, CMH 103 hybrid sunflower, and McGregor flax. The major gene controlling resistance to common root rot was located in wheat and new sources of resistance to stem rust and transgressive segregation for resistance to stem rust were identified in oats.

Improved chemical weed control, particularly for wild oats, accounted mainly for the 29% increase in average wheat yields in a dryland rotation study established in 1912.

Charolais-sired and Simmental-sired cows produced 20–25 kg more weaned calf weight per cow bred than Hereford × Angus cows; and Southdown, Hampshire, and Suffolk rams sired lambs that can be finished for slaughter at different weights to supply specific markets.

Potential for extending the growing season of vegetables was demonstrated by advancing the production of tomatoes and zucchinis in British Columbia by 1 mo, by growing them in polyethylene-covered tunnels.

Prairie Cascade weeping willow and Miniglobe dwarf honeysuckle were released as hardy ornamental cultivars.

Development of new techniques in research included: use of stable isotopes of copper for determining copper status of animals, detection of cold tolerance in genotypes of corn, rapid and reliable determination of glucosinolate levels in Canola seed, a screening technique for resistance to *Myriosclerotinia borealis* in winter cereals and grasses, rapid laboratory determination of susceptibility of grasses to phylloxera infestation, a seedling test to determine resistance of field peas to Ascochyta disease, and use of virus relationships through N-terminal peptides to develop specific antisera for more accurate diagnosis of virus diseases.

Other developments included a new indexing method for the swine record of performance testing program, liming of poorly structured soils in northern Alberta to increase yields, improved leafcutting bee shelters, a technique using sucrose rating to determine potato harvesting times, and a rapid method for early detection of meat-spoilage organisms.

The Region managed the AERD (mechanization and farm buildings), wild oat control, and vertebrate pest control contracting-out programs for the Branch, as well as the station initiatives program for the Region. In the Region, 70 contracts worth $1 318 000 were awarded. Achievements in National programs included development of a bog digger and a blueberry harvester in the Atlantic, improved insulation of corn silos in Ontario, improved recommendations for irrigation with sewage effluent and for control of wild oats on the prairies, and development of a low-cost range fence in British Columbia.

The research program at six stations was assisted by 38 contracts ($1 000 000) funded by the Alberta Research Council.

The establishment of a fuel energy laboratory at the Swift Current Research Station increased regional involvement in energy. Two engineers, a tillage engineer and an economist, were appointed to support the program.

Dr. J. Dueck was appointed Director at the Regina Research Station on 1 July. Dr. A. A. Guitard, the first Director General of the Region, retired on 1 October and was replaced by Dr. J. E. Andrews, who had been Director at the Lethbridge Research Station since 1969. Dr. W. N. MacNaughton was appointed Director at the Lethbridge Research Station on 1 October.

Further information may be obtained by contacting individual research establishments or by addressing inquiries to Western Regional Headquarters, Research Branch, Agriculture Canada, P.O. Box 9241, Saskatoon, Sask. S7K 3X5.

J. E. Andrews

PRÉFACE

La région de l'Ouest, dont l'administration centrale se trouve à Saskatoon, compte 15 stations de recherche, 4 fermes expérimentales et 8 sous-stations qui desservent les collectivités agricoles des provinces des Prairies et de la Colombie-Britannique. En 1981, son budget était de 48 millions de dollars et son personnel comptait environ 355 professionnels et 870 techniciens travaillant à solutionner une large gamme de problèmes agricoles.

Voici quelques-unes des réalisations importantes de la région au cours de la dernière année. Les études du sol et de l'eau ont montré que l'irrigation peut améliorer l'état de certains sols solonetziques en réduisant le niveau de salinité dans la rhizosphère, que le résidu d'une seule application importante de phosphore permet d'accroître le rendement des céréales et des oléagineux pendant au moins huit ans, et qu'une quantité suffisante de potasse dans le sol peut influer sur la productivité des fourrages.

Parmi les cultivars homologués, mentionnons les blés roux vitreux du printemps Ketepwa et Léader qui résistent au cèphre et contiennent une faible quantité d'α-amylase, le canola Tobin résistant à la rouille blanche, le tournesol hybride CMH 103 et le lin McGregor. On a déterminé l'emplacement du principal gène contrôlant la résistance au pourridié commun du blé et on a identifié de nouvelles sources de résistance à la rouille de la tige et la ségrégation transgressive de cette résistance chez l'avoine.

C'est surtout l'amélioration des techniques de désherbage chimique, particulièrement dans le cas de la folle avoine, qui a permis une augmentation de 29% des rendements moyens de blé en culture sèche dans une rotation établie en 1912.

Des vaches de père Charolais et de père Simmental ont donné des veaux sevrés dont le poids moyen (en terme du nombre de vaches accouplées) dépassait de 20 à 25 kg celui des veaux issus de vaches Hereford × Angus; des béliers Southdown, Hampshire et Suffolk ont engendré des agneaux qui peuvent être engraissés pour abattage à différents poids selon la demande sur tel ou tel marché.

Comme on a avancé d'un mois la production de tomates et de courgettes en Colombie-Britannique grâce à des tunnels protecteurs en plastique, il sera dorénavant possible de rallonger la saison de croissance des légumes.

Le saule pleureur Prairie Cascade et le chèvrefeuille nain Miniglobe ont été mis sur le marché comme des cultivars ornementaux rustiques.

Voici quelques-unes des toutes nouvelles techniques qui ont été mises au point: utilisation d'isotopes stables de cuivre pour déterminer le bilan cuprique des animaux, détection de la tolérance au froid dans les génotypes de maïs, détermination rapide et fiable de la teneur en glucosinolate des graines de canola, technique de sélection axée sur la résistance au *Myriosclerotinia borealis* des céréales et des graminées d'hiver, détermination rapide en laboratoire de la sensibilité des graminées au phylloxéra, épreuve au stade de la plantule pour déterminer la résistance des pois de grande culture à la maladie de la tache ascochytique et utilisation des rapports entre les virus, par le biais de l'étude de leurs peptides à NH_2 en bout de chaîne, pour mettre au point des antisérums spécifiques qui permettront l'établissement de diagnostics plus précis des maladies virologiques.

D'autres progrès ont été réalisés dans l'élaboration d'une nouvelle méthode d'indexation pour le Programme de contrôle d'aptitudes des porcs, le chaulage des sols à faible structure dans le nord de l'Alberta pour augmenter les rendements, l'amélioration des abris pour mégachiles, la mise au point d'une technique basée sur le dosage du sucrose servant à déterminer la période opportune de récolte des pommes de terre et une méthode rapide pour détecter au tout début les organismes qui dégradent la viande.

La région s'est occupé des programmes d'impartition des contrats pour la recherche et le développement en génie agricole (mécanisation et bâtiments agricoles), la lutte contre la folle avoine et les parasites vertébrés pour la Direction générale, et du Programme d'initiatives des stations pour la région où 70 contrats d'une valeur de 1 318 000 dollars ont été accordés. Dans le cadre des programmes nationaux, les progrès réalisés ont été les suivants: mise au point d'une trancheuse pour tourbières et d'une récolteuse de bleuets dans les provinces de l'Atlantique, amélioration de l'isolation des silos à maïs en Ontario, recommandations mieux étayées d'irrigation avec les eaux d'égoût et de lutte contre la folle avoine dans les Prairies, et conception de clôtures à coûts modiques pour les parcours en Colombie-Britannique.

Le programme de recherche dans six stations a été appuyé par 38 contrats (1 million de dollars) financés par le Conseil de recherche de l'Alberta.

L'ouverture d'un laboratoire sur les carburants à la station de recherche de Swift Current a rendu la participation régionale plus importante sur le plan de l'énergie. Deux ingénieurs, un ingénieur en travail du sol et un économiste, ont été affectés à ce programme.

J. Dueck a été nommé directeur de la station de recherche de Regina le 1 juillet. A.A. Guitard, le premier directeur général de la région, a quitté ce poste le 1 octobre et a été remplacé par J.E. Andrews qui était directeur de la station de recherche de Lethbridge depuis 1969. W.N. MacNaughton a été nommé directeur de la station de recherche de Lethbridge le 1 octobre.

Pour obtenir de plus amples renseignements, communiquer avec les établissements de recherche ou s'adresser à l'Administration centrale des régions de l'Ouest canadien, Direction générale de la recherche, Agriculture Canada, C.P. 9241, Saskatoon (Sask.) S7K 3X5.

J.E. Andrews

Research Station
Brandon, Manitoba

PROFESSIONAL STAFF

B. H. Sonntag, B.S.A., M.Sc., Ph.D.	Director
S. Bukowski [1]	Administrative Officer
Vacant	Information Officer
Vacant	Systems and programming

Animal Science

J. H. Strain, B.S.A., M.Sc., Ph.D.	Head of Section; Animal breeding and management
A. G. Castell, B.Sc., M.S., Ph.D.	Swine nutrition
R. L. Cliplef, B.Sc., M.Sc., Ph.D.	Meats physiology
G. W. Dyck,[2] B.S.A., M.Sc., Ph.D.	Reproductive physiology
R. R. Grandhi, B.V.Sc., M.Sc., Ph.D.	Swine nutrition
D. L. Grinwich, B.Sc., M.Sc., Ph.D.	Reproduction physiology
G. W. Rahnefeld, B.Sc., M.Sc., Ph.D.	Beef cattle genetics
Vacant	Swine genetics

Plant Science

L. D. Bailey, B.S.A., M.Sc., Ph.D.	Head of Section; Soil–plant relationships
Vacant	Barley breeding
P. N. P. Chow, B.S.A., M.A., Ph.D.	Weed physiology
R. D. Dryden, B.S.A., M.Sc.	Crop culture
R. I. Hamilton, B.Sc., M.S.A., Ph.D.	Corn physiology
Vacant	Plant nutrition
R. B. Irvine,[3] B.S.A., Ph.D.	Barley physiology
R. Simons,[4] B.Sc., M.Sc., Ph.D.	Forage agronomy

Departures

A. J. Dagenais Resigned May 1981, ICRISAT, West Africa	Administrative Officer

K. W. CAMPBELL Resigned December 1981, Ciba-Geigy, Ailsa Craig, Ont.	Barley breeding
R. I. WOLFE Transferred to Beaverlodge Research Station, January 1981	Barley breeding
E. D. SPRATT Resigned August 1981, Potash Corporation of Saskatchewan	Plant nutrition
D. W. HAGBORG, B.Sc., B.A. Transferred to Systems and Consulting Division, Finance and Administration Branch, Ottawa, Ont. September 1981	Systems and programming

VISITING SCIENTIST

M. BUHR, B.Sc., M.Sc., Ph.D.	Reproductive physiology—swine

[1]Appointed September 1981.
[2]Returned from postdoctoral transfer of work to University of Nottingham, August 1981.
[3]Transferred from Swift Current Research Station, September 1981.
[4]Appointed February 1981.

INTRODUCTION

The research program at Brandon encompasses beef cattle breeding; swine nutrition, physiology, genetics, and management; breeding, physiology, and management of barley, corn, soybeans, and sorghum; and soil fertility, agronomy, plant nutrition, and weed control in cereal, oilseed, and forage crops. Research programs are designed to solve production problems and to evaluate new opportunities that will enable Canadian farmers, especially those located in the eastern prairie area, to maintain or improve their competitive position in domestic and foreign markets.

Several important changes occurred in the professional staff in 1981. Dr. R. I. Wolfe, barley breeder, transferred to the Beaverlodge Research Station and was replaced by Dr. R. B. Irvine, cereal physiologist, by way of a transfer from the Swift Current Research Station. Dr. R. Simons, forage agronomist, joined our staff in February. Dr. E. D. Spratt, soil scientist, resigned in August to accept an appointment with the Potash Corporation of Saskatchewan and will be replaced by Dr. J. M. Sadler early in 1982 after tranferring from the Charlottetown Research Station. Dr. K. W. Campbell, barley breeder, resigned in December to accept a position with Ciba-Geigy Seeds Ltd. Dr. M. Buhr joined our staff in November as a postdoctoral fellow in swine reproductive physiology.

This brief report contains highlights of recent findings of our research program. More detailed results can be obtained from our annual Review of Results, from published papers, or by direct contact with research personnel at the Research Station, Research Branch, Agriculture Canada, Box 610, Brandon, Man. R7A 5Z7.

B. H. Sonntag
Director

ANIMAL SCIENCE

Beef cattle

Environmental and genetic effects on preweaning performance of calves from first-cross cows. Calving ease and calf mortality were studied for 4034 calves produced in second and later parities from hybrid females maintained in two contrasting environments, farm-type (Brandon, Man.) and short-grass range (Manyberries, Alta.). The contemporary populations of first-cross dams were mated to four terminal sire breeds: Charolais (C), Simmental (S), Limousin (L), and Chianina (Chi). The dams represented 10 F_1 crosses: the Hereford × Angus (HA) and 9 crosses produced by mating C, L, and S bulls with Hereford, Angus, and Shorthorn cows. Male calves caused greater calving difficulty and experienced higher mortality ($P < 0.0001$) than female calves. Calving ease was not influenced by location, but postnatal mortality, particularly of males, was substantially less at Brandon ($P < 0.0001$) than under the stringent environmental conditions experienced at Manyberries. Differences in calving ease among terminal sire progeny groups were not significant when the four breeds were mated to HA dams, but all paired or three-way comparisons of the Limousin indicated the highest proportion of unassisted births ($P < 0.0001$) and the lowest incidence of difficult births ($P < 0.006$) for this sire breed. No differences in postnatal mortality were observed in paired comparisons of C, S, and L progeny with Chi or in the four breed comparisons with HA dams. However, paired comparisons among the C, S, and L sires indicated a ranking of C > S > L ($P < 0.04$). Breed of dam's dam (Hereford, Angus, Shorthorn) had no influence on calving ease or mortality but breed of dam's sire (C, S, L) was important with progeny from L-sired dams that had the highest incidence of unassisted births ($P < 0.01$) and the highest incidence of postnatal mortality ($P < 0.06$). The proportion of unassisted births increased as the experiment progressed ($P < 0.001$), and this time trend may partly have been caused by the advancing age of the dams. A large location × year interaction existed for this trait ($P < 0.002$), with Manyberries recording substantially greater calving difficulty than Brandon during the first 3 yr, attributed to location differences in environmental stress on the cow. The large winter

weight losses of cows under the Manyberries environment resulted in a much higher ratio of calf birth weight to cow calving weight (10% versus 8%, $P < 0.001$). This interpretation also appeared relevant to interactions for calving ease involving calf sex, year of birth, breed of terminal sire, and location. Calf mortality generally increased with increasing calving difficulty, but the interactions observed for calf mortality suggested that the relationship between calving ease and mortality was influenced by the degree of precalving environmental stress on the dam.

Environmental and genetic effects on preweaning growth traits for 4034 calves born and 3732 calves weaned showed that sex differences were important ($P < 0.0001$), with males averaging 7% heavier at birth and 5% higher in measures of postweaning growth than females. Location differences were negligible for birth weight (1.2%), but preweaning growth rate was 10–13% greater at Brandon ($P < 0.0001$) than at Manyberries. Year differences were large for all traits measured ($P < 0.0001$), and there was evidence that these were influenced by variation in annual weaning date. Progeny rankings by terminal sire breed were Chi > C (2.5%), Chi > S (4.2%), and Chi > L (11.4%) for birth weight (all $P < 0.0001$) and Chi = C = S > L by 6% ($P < 0.0001$) for all measures of preweaning growth. Rankings of the dam crosses by their breed of sire (DS) were C > S > L for birth weight ($P < 0.0001$) and S > C > L for preweaning growth ($P < 0.0002$). The paired DS comparisons indicated S > L by 9.1% and C > L by 2.7%. Ranking of the dam crosses by their breed of dam (DD) were H = N > A ($P < 0.0001$) for birth weight and N > H = A for preweaning growth traits. A location × dam cross interaction was evident for the Charolais × Shorthorn dam cross ($P < 0.1$). Progeny from all dam crosses except the LH and LA at Manyberries grew more rapidly than their contemporary controls (HA progeny), with the crosses averaging 11–14% higher than the HA.

Distribution of time of parturition in beef cows. Data on 1515 calvings were recorded over a 4-yr period at the Agriculture Canada Research Station, Brandon, Man. The distribution of calvings was relatively uniform over the 24-h period. Slightly more calves were born from 7:00 a.m. to 7:00 p.m. (51.5%) than between 7:00 p.m. and 7:00 a.m. The distribution of 212 calvings in which difficult delivery was experienced was significantly uneven. The highest incidence of abnormal calvings occurred from 11:00 a.m. to 3.00 p.m. (22.2%) and the lowest from 11:00 p.m. to 3:00 a.m. (12.1%).

Swine

Feeding interval and the reproductive performance of gilts. The feasibility of alternate-day feeding during gestation to save feeding time was evaluated for Lacombe and Yorkshire gilts housed in outside pens in the fall. Gilts became accustomed to alternate-day feeding in the first 2 wk. Feeding 4.4 kg every other day compared with daily feeding of 2.2 kg significantly ($P < 0.05$) reduced the gestation weight gain (35 versus 45 kg). Alternate-day feeding also reduced the number of live pigs born and weaned for Yorkshire (8.6, 7.8 versus 9.5, 8.8) but not for Lacombe gilts (9.5, 7.7 versus 8.9, 7.0). The mean birth weight and 5-wk weight gains (kilograms) of piglets were similar (1.27, 7.75 versus 1.25, 7.89) for both alternate-day and daily-fed groups.

Consumer acceptance of market weight boar pork. Fifty families participated in a consumer preference test involving fresh and processed (cured and smoked, seasoned) product from paired-litter mate boars and barrows of market weight (90 kg). Preliminary results indicate no significant trend of preference of one over the other. Hams and bacon of the boar pigs had a higher shrink (percentage loss in weight) during processing, however.

Boar taint physiology. Serum levels of 5α-androsterone and testosterone and the 5α-androsterone level in backfat was monitored at weekly intervals in 12 mature boars and 14 stags of Lacombe and Yorkshire breeding for a period of 13 wk. The 14 stags were selected at random from among the mature boars and were castrated at the start of the experiment (wk 1). Apparent differences in serum testosterone were visible at wk 2, but differences in serum 5α-androsterone were not apparent until wk 5. The level of 5α-androsterone in backfat showed an apparent decrease by wk 6, a sharp decrease by wk 9, and was almost nonexistent by wk 12. During the total test period of 13 wk, the stags (castrates) gained an average of 67 kg whereas the boars (controls) gained an average of 92 kg.

Restricted suckling as a method to reduce the rebreeding interval in swine. Restricted suckling was tested as a potential means to control estrus cycle activity and reduce the rebreeding interval in swine. Preliminary results indicate that restriction of suckling beginning at 3 wk postpartum allowed sows to be bred during lactation, on the average 9.8 days earlier than an unrestricted group, and made possible a projected potential of 2.4 farrowings per year or 15 piglets born per sow annually.

Control of farrowing. The injection of a prostaglandin analogue (175 μg Cloprostenol) into Yorkshire gilts at 111–114 days of pregnancy induced farrowing 24–35.5 h postinjection in 100% of the animals. This procedure eliminated overnight attendance, allowed more efficient cross fostering of litters, and and saved on labor costs.

PLANT SCIENCE

Wheat

Wheat production and management—long-term rotation studies. Continuous cropping (1958–1980) with wheat using recommended fertilizer rates gave significantly more wheat grain per hectare annually than wheat–wheat rotations containing summerfallow. Wheat–fallow on alternate years (using phosphate fertilizer) gave less wheat per hectare annually than wheat–wheat–fallow (using soil test fertilizer recommendations). Without fertilizer, wheat production in rotation containing fallow was not maintained, whereas the response to fertilizer-N for continuous cropping and stubble cropping increased with time. The response to phosphate fertilizers by wheat after fallow remained constant (about 250 kg/ha). When the straw was removed by baling from the 3-yr rotation of wheat–wheat fallow, the yields were consistently higher (a result of better seeding) but not significantly different. Significant differences in levels of organic matter were not found between the single-culture wheat rotations or between straw treatments. Organic matter was increased by growing grass–legume in the rotation for 4 yr in a 6-yr rotation. The highest yields of wheat were obtained after hay/break and fallow with the yields tending to increase in the latter years. Sweet clover (SC) in the 3-yr wheat–wheat/SC–SC/fallow rotation (no fertilizer) gave wheat yields equivalent to the other single-culture wheat–fallow rotations using fertilizer. High protein content of wheat (15–16%) was obtained in the wheat–legume rotations.

Weed control in wheat. A 3-yr study tested herbicides for emergency use after soil-incorporated herbicides (triallate and trifluralin) failed to control wild oats in wheat because of unfavorable weather. The emergency herbicides (barban, flamprop-methyl, and difenzoquat) improved control of wild oats and resulted in a slight increase in wheat yield over triallate alone and a considerable increase over trifluralin alone.

Wild oats control and nitrogen fertilizer in wheat. In a 3-yr experiment, similar results, with yield increases up to 100%, were obtained with granular or solution formulations of triallate when applied in the fall with granular or solution formulations of nitrogen fertilizer. Treatments were incorporated into the soil with a disc and harrow. Solution formulations of triallate were more effective than granular formulations for the control of wild oats when incorporated with a harrow after seeding in the spring. When triallate was applied with nitrogen (N) fertilizer, yields from spring treatments were improved by as much as 60%.

Other cereals

Barley production and management. Field and growth chamber experiments have shown that the nitrification inhibitor N-serve prevents the oxidation of NH_4^+ to NO_3^- in soils, thus preventing losses of N as a result of denitrification and leaching of NO_3^- from fall-banded N. When N-serve was mixed with fall-banded granular and liquid N, yields of barley were similar to those obtained from spring-banded N.

Corn physiology. Differences between hybrids and inbreds in growth at low temperature (10–12°C) following germination have been measured. The preliminary observations have included qualitative observations of leaf emergence, maintenance of color, root development, and quantitative measurement of root and shoot development and yield. Large differences have been observed among hybrids and among recommended hybrids.

Sorghum evaluation. Grain sorghum cultivars and hybrids performed extremely well with several lines yielding 6–7 t of grain per

hectare. Further (S2) development of promising sorghum lines from the Purdue University population occurred.

A and B sorghum lines from around the world were assessed for adaptation at Brandon. Several were successfully increased, though none appeared outstanding.

Several of the earliest known sources of pearl millet were successfully grown at Brandon in 1981. *Pennisetum americanum* (L.) has not previously been successfully grown for grain this far north and in this cool environment. The earliest segregate flowered in late July and showed extremely good vigor in the spring.

Weed control in corn and sorghum. A 3-yr study on 12 recommended treatments for corn indicated that the preplant incorporation of atrazine plus butylate or the postemergence application of atrazine plus oil in a band over the row followed by inter-row cultivation controlled grasses and broad-leaved weeds. Yields were increased by 114 and 123%, respectively.

The preplant harrow incorporation of alachlor, a nonresidual compound, has been included as a new recommendation for the control of green and yellow foxtail in corn for Manitoba.

Successful control of grassy weed was achieved using Concep (Ciba-Geigy), a safener applied to sorghum seed, and the nonresidual metolachlor. Control of grassy weed is now feasible with a nonresidual herbicide.

Oilseed crops

Soybean evaluation and physiology. In spite of several nights with near frost at emergence and rather cool and damp conditions, several promising cultivars with yield and maturity advantages combined with stable protein content have moved to final assessment in 1982. The new soybean Maple Amber has shown excellent performance in seed-increase fields and has higher protein content than all present standards. Shelling prior to harvest was above normal in 1981, thus enabling selection for this characteristic.

Soybean production and management. Under field conditions, granular inoculant placed with the seed (SD) was more effective in increasing yield and protein than soil implantation of a granular inoculant (SI) or coating the seed with a powdered inoculant prior to seeding (SC). The SD method promoted nodulation at the second stage of vegetative growth, the SI method at the third vegetative stage, and the SC method delayed nodulation to the second reproductive stage. Furthermore, at the fourth reproductive stage, when nodule numbers were maximum, the SD inoculated plants had more and larger pink nodules (30–34) than the plants inoculated with SI (24–34) or SC (10–20). The largest yield increases were obtained on the SD-inoculated plots, and only on these plots did seed protein exceed 40%. A foliar application of N at 60 kg/ha (urea) on the SD plots resulted in increases in yield and protein content (>43%).

Soybean yield and protein content increased with increasing rates of N applied to the soil (NH_4NO_3) in the absence of an inoculum. However, although yields obtained with N at 120 kg/ha were similar to those obtained with SD inoculant, the protein content was significantly less (38% versus 42%).

Weed control in flax, rapeseed, and soybeans. The addition of each of five nonionic surfactants at 0.5% of spray solution increased control of wild oats of BAS 9052 at a reduced rate (0.1 kg/ha). The combination of a surfactant and ammonium sulfate (0.5%) further increased control of wild oats. Of five sulfate and six ammonium ions each applied at a concentration of 0.004 *M* (with a surfactant), ammonium sulfate was the most effective. In the field, BAS 9052 at half the recommended rate (0.15 kg/ha) gave the same control of wild oats, volunteer barley, wheat, and corn as did the recommended rate, provided a surfactant and ammonium sulfate were added to the herbicide. In soybeans, BAS 9052 with PP 021 gave excellent control of grasses and broad-leaved weeds and resulted in a large increase in bean yield. Dowco 453 at 0.1–0.2 kg/ha gave excellent control of wild oats and green foxtail in three oilseed crops.

Control of volunteer barley and wheat. Control of volunteer cereals in rapeseed with BAS 9052 was studied in collaboration with Lacombe, Regina, and Scott in 1979 and 1981. BAS 9052 at 0.3 and 0.4 kg/ha with 0.5% Atplus 411F surfactant in the spray solution gave excellent control of barley and wheat, resulting in significant rapeseed yield increase. In the greenhouse, of 14 barley and 10 wheat cultivars, most were completely controlled by BAS 9052 at 0.3 kg/ha, with

less control of Summit barley, Wakooma and Coulter durum, and Glenlea utility wheat.

Forage crops

Alfalfa production and management. In field studies, some clay loam soils with high levels of exchangeable potassium (K) (>900 kg/ha) required K fertilizer to produce maximum yields of alfalfa forage. Other soils with less exchangeable K (600–700 kg/ha) required no K to maximize alfalfa forage yields over a 5-yr period. This field study confirms the results of previous greenhouse studies, which showed that the ability of a soil to supply plants with K (the potential potassium power, PKSP) was not related to its exchangeable K level.

PUBLICATIONS

Research

Cliplef, R. L.; Strain, J. H. 1980. Relationship of sex odor to panel acceptability and certain other organoleptic characteristics of pork chops. Can. J. Anim. Sci. 61:45-52.

Dyck, G. W.; Palmer, W. M.; Simaraks, S. 1980. Progesterone and luteinizing hormone concentration in serum of pregnant gilts on different levels of feed consumption. Can. J. Anim. Sci. 60:877-884.

Fredeen, H. T.; Weiss, G. M.; Lawson, J. E.; Newman, J. A.; Rahnefeld, G. W. 1981. Lifetime reproductive efficiency of first-cross beef cows under contrasting environments. Can. J. Anim. Sci. 61:539-554.

Fredeen, H. T.; Weiss, G. M.; Rahnefeld, G. W.; Lawson, J. E.; Newman, J. A. 1981. Growth patterns of cows under two environments. Can. J. Anim. Sci. 61:243-259.

Grandhi, R. R.; Strain, J. H. 1980. Effect of biotin supplementation on reproductive performance and foot lesions in swine. Can. J. Anim. Sci. 60:961-969.

Grandi, R. R.; Strain, J. H. 1981. Choline supplementation of barley–wheat–soya diets and the reproductive performance of swine. Can. J. Anim. Sci. 61:803-808.

Harris, K. H.; Murphy, B. D.; Grinwich, D. L. 1981. Characteristics of luteal function in the superovulated pseudo pregnant hamster. Biol. Reprod. 25:699-707.

Moyer, J. R.; Chow, P. N. P.; Dryden, R. D. 1981. Triallate herbicide application with dry and solution nitrogen fertilizers. Can. J. Plant Sci. 61:107-114.

Sadler, J. M.; Bailey, L. D. 1981. Growth and uptake of soil and fertilizer P by flax in response to various placements and rates band applied phosphorus. Can. J. Soil Sci. 61:303-310.

Spratt, E. D.; Warder, F. G.; Bailey, L. D.; Read, D. W. L. 1980. Measurement of fertilizer phosphorus residues and its utilization. Soil Sci. Soc. Am. 44:1200-1204.

Miscellaneous

Dyck, G. W. 1981. Pregnancy diagnosis. *In* D. J. A. Cole and G. R. Foxcroft, eds. Control of pig reproduction. University of Nottingham 34th Easter School in Agricultural Science. Butterworth, London.

Grandhi, R. R.; Strain, J. H.; Piloski, A. P. 1981. Feed restriction for growing-finishing hogs. Canadex 440.56.

Research Station
Morden, Manitoba

PROFESSIONAL STAFF

D. K. McBeath, B.S.A., M.Sc., Ph.D.	Director
H. G. Brodie	Administrative Officer
M. P. Reimer	Information Officer and Photographer

Field Crops

G. H. Friesen,[1] B.S.A., M.Sc., Ph.D.	Head of Section; Weed science
S. T. Ali-Khan, B.S.A., M.Sc., Ph.D.	Breeding of field peas
C. G. Campbell, B.S.A., M.Sc., Ph.D.	Breeding of buckwheat
J. Giesbrecht, B.S.A., M.Sc., Ph.D.	Breeding of grain corn
G. H. Gubbels, B.S.A., M.S.A., Ph.D.	Crop management, physiology
R. C. Zimmer, B.Sc., Ph.D.	Diseases of field peas

Horticultural Crops

B. B. Chubey, B.S.A., M.Sc., Ph.D.	Head of Section; Quality of essential oils, new and special crops
W. G. Ronald, B.S.A., M.Sc., Ph.D.	Breeding of woody ornamentals
W. A. Russell, B.S.A.	Breeding of potatoes
D. E. Vanstone, B.S.A., M.Sc., Ph.D.	Management, breeding of ornamentals

Oilseed Crops

E. O. Kenaschuk, B.S.A., M.Sc., Ph.D.	Head of Section; Breeding of flax
W. Dedio, B.Sc., M.Sc., Ph.D.	Breeding of sunflower
J. A. Hoes, B.S.A., M.S.A., Ph.D.	Pathology of flax and sunflower

Departures

W. O. Chubb, B.Sc., D.Sc. Retired November 1981	Herbicides
H. C. Huang, B.Sc., M.Sc., Ph.D. Transferred to Lethbridge, October 1981	Pathology of sunflower
H. H. Marshall, Hon. D.Sc. Retired September 1981	Horticulturist

VISITING SCIENTISTS

Pearson fellows, International Development Research Centre

T. F. Holo Agricultural Research Division, Ministry of Agriculture, Forest and Fisheries, Tongatapu, Tonga	Research management
V. S. J. Yogiyo Department of Primary Industry, Highlands Agricultural Experiment Station, Aiyura, Kainantu, Papua New Guinea	Research management

---

[1]Seconded to CIDA Indo-Canadian research project for dryland agriculture.

INTRODUCTION

The programs of the Morden Research Station are directed toward the development of new cultivars and improvement of management for buckwheat, field corn, field peas, pulses, flax, sunflowers, potatoes, herbaceous and woody ornamentals, and new crops. This report summarizes some of the results of research conducted during 1981.

Breeding and evaluation programs resulted in the licensing of McGregor flax and the release of six lines of sunflowers, one line of semileafless peas, Prairie Cascade weeping willow, Miniglobe dwarf honeysuckle, and Columbia Jerusalem artichoke. Evaluations were continued on promising cultivars of other crops. Refinements were developed for several management practices which may lead to increased productivity. Additional understanding was obtained of several diseases that affect crops. Information was generated on several new herbicides, which may lead to registration of these products and more effective weed control in the future.

Further information on any of these research activities, reprints of publications listed in this report, and copies of previous reports may be obtained from the Research Station, Research Branch, Agriculture Canada, P.O. Box 3001, Morden, Man. R0G 1J0.

D. K. McBeath
Director

FIELD CROPS

Buckwheat

Breeding. Three large-seeded selections were advanced to the buckwheat cooperative trials. Lines with semidwarf plant habit were advanced to replicated yield trials. Incorporation of resistance to downy mildew into commercially acceptable lines has reached the first backcross stage.

Management. Four growth retardants, daminozide, chlormequat, ancymidol, and BAS 0660W, were applied to field-grown buckwheat at early stages of growth to evaluate their effectiveness in reducing lodging. None of the treatments reduced plant height or lodging. Daminozide increased average seed weight in each of the 3 yr of the study and increased seed yield in 1 yr of the 3.

Disease. Resistance to downy mildew (DM) has been stable in seven buckwheat lines for the past 2 yr and continues to be heritable. In 2 yr of testing, Ridomil proved effective as a foliar spray to control DM; three sprays gave optimum control with greatest increase in yield.

Field corn

Support for licensing of four new grain corn hybrids was obtained from the Manitoba Corn Committee. These hybrids could be on the market by 1984. Seed production should be relatively easy because all four are three-way hybrids. They are early maturing (2150–2000 corn heat units), yield well, and have healthy stalks.

A definite breakthrough with respect to early maturity in corn appears to have been made. The first experimental hybrid has been produced which has good agronomic traits and requires only 2100 corn heat units to reach physiologic maturity. This is 50 units less than is required by Pioneer 3995, the earliest maturing hybrid on the market. The new hybrid is equal to Pioneer 3995 in yield of grain, has 3.3% less moisture, and has less than 1% stalk breakage. Should these results be verified in future trials, this hybrid should help to reduce the risk of growing corn in Western Canada and expand the area where corn can be grown successfully for grain production.

A number of promising experimental hybrids, requiring 2150 heat units to mature, have been produced from inbreds of diverse backgrounds that originated from crosses involving the sweet corn variety Doriny, Missouri inbred Mo 17, Morden Synthetic A, the French inbred EP1, Morden inbred CM 139, and others.

Field peas

Breeding. Two semileafless lines of peas, MP 919 and MP 926, with Century and Trapper background, were evaluated in cooperative tests. In 2 yr of testing, MP 919

produced yields equal to Century's and had similar agronomic and quality characteristics. MP 926, tested for the 1st yr, showed higher yields than Trapper with slightly larger seed size. The germ plasm of MP 919 has been released.

MP 843, a green-seeded selection, continued to show superior seed color but its yield has been 10–15% lower than Century's in cooperative tests. A breeding program has been initiated to increase its yield while maintaining color quality.

Management. Increasing plant populations from 500 000 to 1 000 000 plants/ha, and N and P fertilization levels from 20 to 40 kg/ha, did not affect the yield of the semileafless pea line MP 919.

Disease. Fungicide treatment increased emergence of sound seed of some field pea cultivars. Emergence of Century and Tara was increased by fungicides Captan 50, Thiram 75, Benlate-T, and Benlate–Captan. However, emergence of Trapper was not significantly increased by fungicide treatment.

The rate of development of leaf infection by the *Ascochyta* blight pathogen, *Mycosphaerella pinodes*, differed among the field pea cultivars Century, Tara, Trapper, and Triumph. Two disease reaction groups were found, with Century and Trapper comprising the more susceptible group and Tara and Triumph the more resistant one. As inoculum level and postinoculation period increased, differences in severity of infection among cultivars decreased.

PULSE CROPS

A new red lentil cultivar, Red Chief, obtained from the USA, showed good yield in Manitoba. At present no red lentil cultivars are available for production in Canada. Five new navy bean cultivars yielded significantly higher then the recommended cultivar Seafarer. Cultivars of black, pinto, Great Northern, and pink beans continued to perform well in Manitoba.

Two lines of *Lathyrus sativus* and one line of *L. cicera* have been shown to contain low levels of *n*-oxalyldiaminopropionic acid and produce acceptable yields at Morden.

OILSEED CROPS

Flax

Breeding. The flax cultivar McGregor, developed from crosses involving Raja, Redwood 65, and Rocket, was licensed. McGregor matures in the same time as Dufferin but is about 7% higher yielding and has better lodging resistance. It is similar to Dufferin in oil quality but is about 1% lower in oil content. The rust resistance of McGregor is conditioned by the K^1 gene derived from Raja and probably the L^4 gene derived from Rocket.

In a date-of-seeding test (10 and 20 May; 1, 10, and 20 June) at Morden, McGregor outyielded Dufferin on all dates but 10 May. The promising line FP 698 outyielded the early cultivar Linott by 3–16% on the 10 May, 1 June, and 10 June seeding dates.

Diseases. The rust resistance of Raja was found to be conditioned by a new gene designated as K^1. The gene has resistance against all current North American rust races.

Genetic studies indicate that the postseedling rust resistance of Norland is conditioned by a single, partially dominant gene. Rust reaction of F_1 plants from Summit × Noralta indicates a lack of dominance for the postseedling resistance of Noralta.

Sunflowers

Breeding. Six sunflower inbred lines, CM 338, CM 361, CM 497, CM 526, CM 586, and CM 587, were released for use in hybrid combinations or as germ plasm for further breeding. CM 338 is early maturing with good combining ability and is resistant to rust. CM 361 has dominant resistance to verticillium wilt and tolerance for sclerotinia wilt. Both CM 338 and CM 361 are available in a cytoplasmic male sterile form. CM 497 and CM 526 are tolerant of sclerotinia wilt. CM 586 and CM 587 are early restorer lines with good combining ability.

Diseases. A new race ("race 3") of downy mildew, reported first in 1980 from a few scattered locations in the northern United States, has been identified in a Manitoba sunflower field. Current hybrid varieties are all susceptible to this race. It is still to be determined how widely race 3 is distributed in the sunflower production areas of Western Canada.

HORTICULTURAL CROPS

Ornamental crops

Breeding. Two woody ornamentals were described and introduced in 1981 through the Canadian Ornamental Plant Foundation and distributed to about 30 commercial nurseries. *Salix* 'Prairie Cascade', a weeping willow introduction resulting from hybridization, *S. pentandra* × *S. sepulcralis*, combines the hardiness and glossy foliage of its female parent with the weeping growth form and golden stem color of its male parent. The hardiness of this selection indicates that it should provide a reliable weeping willow for landscape use in zone 3 and possibly zone 2 of the Canadian plant hardiness map. *Lonicera* 'Miniglobe' is a compact shrub suitable for use in foundation and shrub bed plantings. It was selected from a second-generation seedling population of *L. xylosteoides* 'Clavey's Dwarf'. Plants of Miniglobe grow to 60 cm tall and 60 cm wide at 6 yr of age, and possess superior plant hardiness compared with existing cultivars.

The anthocyanin pigments of roses, namely cyanin, peonin, and pelargonin, were found to be highly heritable from seed or pollen parent. Inheritance was quantitative, particularly for cyanin and peonin, and a negative correlation existed between peonin and pelargonin.

Monarda selections with improved ornamental characteristics and disease resistance were identified.

Arboretum and evaluation. New plantings were established for evaluation of spirea and vine collections, and 195 woody and 21 herbaceous accessions were acquired. A staminate clone of *Populus grandidentata* was discovered from a small Manitoba outlier stand of this rare but promising large-toothed aspen species. Japanese elm selections exhibited high resistance to field inoculation with the causal agent of Dutch elm disease, *Ceratocystis ulmi*.

Propagation. Propagation of Morden Cardinette roses by commercial growers was monitored and found acceptable following the release of new technology in 1980. Japanese elm selections were budded on a Japanese elm rootstock with poor results but were grafted successfully. Methodology developed in 1979 for propagating Tower poplar from root cuttings has resulted in the rapid commercial acceptance of this new cultivar. Among several F_2 hybrids of basswood, *Tilia cordata* × *T. americana*, one seed strain showed potential as a rootstock based on rapid germination and seedling uniformity.

Nursery management. Herbicide evaluations were continued on various nursery crops in containers and in the field. Significant progress has been made in the evaluation of oxadiazon, resulting in its full recommendation by the Expert Committee on Weeds for use in nursery stock. Oxyfluorfen provided consistent weed control in cedar, spruce, and pine without phytotoxicity to the nursery crop.

Snow cover was shown once again to provide excellent winter protection for the roots of containerized broad-leaved and coniferous crop species.

Fruit breeding. Two fruit selections, PF 36 apple (Rescue × Haralson) and X-10-27 apricot, showed continued promise and stock was increased for introduction. Annual or fall-bearing raspberry selections produced a heavy crop about 15 August and demonstrated their ability to develop precocious fruiting canes after having been mowed to ground level the previous fall.

Potatoes

Breeding and evaluation. Four new cultivars were recommended to prairie growers as a result of prairie regional potato trials. The tablestock seedling FS 6222 is as early as Warba but has much smoother tubers and shallower eyes. Seedling G712-1 develops good-sized tubers earlier than Norchip and produces higher early yields of chipping-quality tubers. However, Norchip outyields G712-1 as a maincrop and storage chipping potato. Shepody produces acceptable yields of tubers of french-fry quality 10–14 days earlier than the standard Russet Burbank. Test marketings have shown that the yellow-fleshed potato Yukon Gold is acceptable to consumers in the Winnipeg area.

Quality. Under dryland conditions in 1980 and 1981 spacing trials, hollow heart in potato tubers of the cultivar Lemhi Russet was not reduced by spacing of seed sets at 22, 30, 38, or 46 cm apart in the row. In 1980 and 1981, respectively, hollow heart occurred in 50 and 41% of tubers 5 cm in diameter and up to 285 g in weight, and in 84 and 80% of tubers weighing more than 285 g.

A useful management tool was developed for the chip potato industry using sucrose content of the tubers. It provides the producer with an objective measure for timing vine-killing prior to harvest, for establishing harvest dates, and for identifying fields where tubers have the best maturity and potential for long-term storage. In storage, an increase in sucrose levels has been observed during sprout inhibition and in early spring when tuber dormancy is broken. These findings have led to recommendations for improving storage management, including the use of intermittent ventilation during sprout inhibition and in early spring, and the utilization of stored potato tubers as soon as dormancy is broken.

Herbicides. Studies on herbicides for control of weeds in potatoes, using the potato cultivar Oneida, provided the following significant findings: (*a*) previous results were confirmed which showed that EPTC plus metribuzin mixtures, applied preplanting and incorporated into the soil, provided season-long control of both grass-type and broad-leaved weeds; (*b*) the addition of a herbicide extender to EPTC did not alter its effectiveness or persistence; (*c*) mixtures of metolachlor plus metribuzin were almost as effective as EPTC plus metribuzin; (*d*) EPTC and vernolate, with or without extenders, did not control wild mustard; and (*e*) the postemergence experimental herbicides fusilade, diclofop, and sethoxydim were very effective on grass-type weeds including volunteer barley, but did not control broad-leaved weeds. Tank mixtures or sequential treatments with metribuzin or bentaxon provided broad-spectrum weed control.

New crops

A new cultivar of Jerusalem artichoke named Columbia, formerly tested as M-6, was released in 1981. This high-yielding cultivar with tan-colored, white-fleshed tubers bears 4–10 basal branches and reaches a height of 135–170 cm.

Seventy-seven accessions (62 white and 15 red) were evaluated for tuber yield, inulin content, and plant height. Tuber yields ranged from 5210 to 86 520 kg/ha; inulin ranged from 25.4 to 80.5% dry weight; and heights ranged from 110 to 250 cm.

Japanese artichoke, *Stachys affinis* Bunge. (*S. sieboldii*), horseradish, and garlic yielded 13 013, 9170, and 15 000 kg/ha, respectively.

A tetraploid geraniol-rich monarda bearing viable seeds was developed. This is a breakthrough, since the only previously available high-geraniol monarda was a triploid and could be propagated only by asexual means.

PUBLICATIONS

Research

Gubbels, G. H. 1981. Quality, yield and seed weight of green field peas under conditions of applied shade. Can. J. Plant Sci. 61:213-217.

Gubbels, G. H.; Kenaschuk, E. O. 1981. Desiccation of flax with diquat. Can. J. Plant Sci. 61:575-581.

Huang, H. C. 1981. Tan sclerotia of *Sclerotinia sclerotiorum*. Can. J. Plant Pathol. 3:136-138.

Huang, H. C.; Hoes, J. A. 1980. Importance of plant spacing and sclerotial position to development of sclerotinia wilt of sunflower. Plant Dis. 64:81-84.

Lafond, G.; Ali-Khan, S. T.; Evans, L. E. 1981. Comparison of near isogenic leafed, leafless, semi-leafless and reduced stipule lines of peas for yield and associated traits. Can. J. Plant Sci. 61:463-465.

Vanstone, D. E.; Ronald, W. G. 1981. Comparison of bare-root versus tree spade transplanting of boulevard trees. J. Arboric. 7(10):271-274.

Miscellaneous

Chubey, B. B.; Gubbels, G. H.; Ali-Khan, S. T. 1981. Good management practices improve cooking quality of field peas. Canadex 142.12.

Gubbels, G. H. 1981. How to build a collapsible plastic greenhouse. Agric. Can. Publ. 1719. 13 pp.

Hoes, J. A.; Huang, H. C. 1980. Effect of population density on development of sclerotinia wilt and yield of sunflower. Proc. 9th Int. Sunflower Conf., 8–13 June 1980, Torremolinos, Spain, Part I. pp. 275-280.

Huang, H. C.; Marshall, H. H. 1980. Screening chrysanthemums for resistance to fusarium wilt. Canadex 636.

Zimmer, R. C.; Russell, W. A. 1981. The rhizoctonia disease on Netted Gem potatoes in southern Manitoba in 1980. Can. Plant Dis. Surv. 61(2):39-40.

Research Station
Winnipeg, Manitoba

PROFESSIONAL STAFF

D. G. Dorrell, B.S.A., M.Sc., Ph.D.	Director
M. D. Hamilton	Administrative Officer

Scientific Support

M. Malyk,[1] B.Sc., M.Sc., M.L.S.	Librarian
W. Romanow, B.S.A., M.Sc.	Scientific Liaison Officer

Cereal Breeding

D. Leisle, B.S.A., M.Sc., Ph.D.	Head of Section; Durum wheat breeding
V. M. Bendelow, B.Sc., M.Sc., Ph.D.	Cereal chemistry
D. Brown, B.S.A., M.Sc.	Oat breeding
A. B. Campbell, B.S.A., M.Sc., Ph.D.	Common wheat breeding
E. M. Czarnecki, B.S.A., M.Sc.	Common wheat breeding
P. L. Dyck, B.S.A., M.Sc., Ph.D.	Wheat genetics
E. R. Kerber, B.S.A., M.Sc., Ph.D.	Wheat cytogenetics
M. I. P. Kovacs, B.Sc., M.Sc., Ph.D.	Cereal chemistry
D. R. Metcalfe, B.S.A., M.Sc., Ph.D.	Barley breeding and genetics
R. I. H. McKenzie,[2] B.S.A., M.Sc., Ph.D.	Oat breeding and genetics
J. S. Noll, B.Sc., Ph.D.	Physiology

Cereal Diseases

R. Rohringer,[3] Dr. sc. agr.	Head of Section; Molecular biology of cereal rust
J. W. Martens, B.Sc., Ph.D.	Acting Head of Section; Oat stem rust
C. C. Gill, B.Sc., Ph.D.	Viruses
G. J. Green, B.S.A., M.Sc., Ph.D.	Wheat stem rust
D. E. Harder, B.Sc., M.Sc., Ph.D.	Oat crown rust
N. K. Howes, B.Sc., Ph.D.	Molecular biology

W. K. Kim, B.Sc., M.Sc., Ph.D.	Molecular biology of cereal rust
J. J. Nielsen, Dr. sc. agr.	Smuts
D. J. Samborski, B.S.A., M.Sc., Ph.D.	Wheat leaf rust
A. Tekauz, B.Sc., M.Sc., Ph.D.	Leaf diseases
P. L. Thomas, B.S.A., M.Sc., Ph.D.	Microbial genetics, smuts

Cereal Crop Protection

S. R. Loschiavo, B.Sc., M.Sc., Ph.D.	Head of Section; Stored grain insect biology
D. Abramson, B.Sc., M.Sc., Ph.D.	Mycotoxicology
P. S. Barker, I.A., M.Sc., Ph.D.	Biology and control of stored grain pests
J. T. Mills, B.Sc., Ph.D., D.I.C.	Seed storage pathology
W. Romanow, B.S.A., M.Sc.	Insect surveys and control
D. Sabourin, B.Sc., M.Sc.	Biometrics
R. N. Sinha, B.Sc., Ph.D.	Ecology of granary insects, mites, and fungi
L. B. Smith, B.Sc., M.S.A., Ph.D.	Population dynamics
N. D. G. White, B.Sc.Agr., M.Sc., Ph.D.	Storage pest control

Integrated Pest Control

W. J. Turnock, B.S.A., M.Sc., Ph.D.	Head of Section; Ecology and population dynamics
G. L. Ayre, B.S.A., M.S.A.	Insect ecology
R. P. Bodnaryk, B.A., M.Sc., Ph.D.	Nutritional physiology
G. K. Bracken, B.Sc., M.Sc., Ph.D.	Physiology and behavior
G. H. Gerber, B.S.A., Ph.D.	Reproductive physiology
B. M. Hegdekar, B.Sc., M.Sc., Ph.D.	Insect biochemistry
R. J. Lamb, B.Sc., M.Sc., Ph.D.	Systems biology
H. G. Wylie, B.A., Ph.D.	Host–parasite relations

Departures

G. E. Bucher, B.A., M.A., Ph.D. Retired 30 December 1981	Insect pathology
F. G. Kosmolak, B.Sc., Ph.D. Resigned 21 October 1981	Cereal chemistry
F. L. Watters, B.Sc., M.Sc., Ph.D. Retired 30 December 1981	Head, Cereal crop protection
P. H. Westdal, B.Sc., M.Sc., Ph.D. Retired 30 December 1981	Biology and control of field crop insects

VISITING SCIENTISTS

HUANG, HUI-GEN, B.S.A. Chinese Scholar	Pathology of smut fungi
A. M. THERRIEN, A.Sc., B.Sc., Ph.D. NSERC Visiting Fellow	Oat genetics

Research Associates

H. A. H. WALLACE, B.Sc., M.Sc.	Microflora of stored seed
F. J. MADRID, B.Sc., Ph.D.	Grain storage, ecology
D. R. WATERER, B.Sc.	Grain storage, ecology

Graduate students

C. AITCHISON, B.Sc., M.Sc.	Entomology
A. AL-HITTY, B.Sc.	Entomology
B. S. JOIA, B.Sc., M.Sc.	Entomology
M. HOWLADER, B.Sc., M.Sc.	Entomology
G. MAITEKI, B.Sc.	Entomology
P. PETERSON, B.S.A.	Plant breeding
D. SINGH, B. Tech. (Ag. Eng.)	Agricultural engineering

[1]Seconded from Libraries Division, Finance and Administration Branch.
[2]On transfer of work to the Crop Research Division, DSIR, Palmerston North, New Zealand, October 1981–April 1982.
[3]On transfer of work to the Institute of Plant Pathology and Plant Protection, University of Gottingen, Germany, April 1981–January 1982.

INTRODUCTION

Research programs at the Winnipeg Research Station emphasize three broad responsibilities: development of improved cultivars of cereals adapted to regions of the Canadian prairies, research on the protection of stored seed and seed products, and research on the integrated control of insect pests of field crops.

Improvement of cereal cultivars, historically the first mandate of the Research Station, requires close cooperation between plant breeders, geneticists, cytologists, plant pathologists, and cereal chemists. The hard red spring wheat cultivar Katepwa, which is similar to the popular cultivar Neepawa but which has a significantly greater resistance to leaf and stem rust, was licensed in 1981. There was a rust epidemic in 1981, with race C53 of stem rust, noted several years ago, predominating in the traditional rust area of the eastern prairies. The new cultivars Benito and Columbus are resistant to all current races of rust.

Research on the preservation of grain and oilseeds and their products is national in scope and requires close cooperation with Plant Products and Quarantine Division of Agriculture Canada, the Canadian Grain Commission, and the grain industry. Factors that cause the development of toxins in stored grain are being investigated as part of a strong mycotoxin program.

Research on the control of field crop insects, particularly those that attack rapeseed, includes the evaluation of new insecticides, an assessment of economic damage, and the development of management systems.

Drs. G. E. Bucher, F. L. Watters, and P. H. Westdal retired at the end of 1981 after a combined total of 120 yr of distinguished service to Agriculture Canada and their profession of entomology. Dr. F. G. Kosmolak resigned in October for medical reasons after a short but productive career as a cereal chemist.

Further information summarized in this report can be obtained from Research Station, Research Branch, Agriculture Canada, 195 Dafoe Road, Winnipeg, Man. R3T 2M9.

D. G. Dorrell
Director

BREEDING, GENETICS, AND CYTOGENETICS

Breeding programs for common wheat, durum wheat, barley, and oats emphasize production of high-yielding cultivars with improved agronomic characteristics and resistance to rusts, smuts, and other cereal diseases. Good quality is a primary objective, involving milling and baking characteristics in common wheat, semolina quality in durum wheat, malting quality in barley, and feeding quality in wheat, oats, and barley.

Barley

Four sister-selections of barley, similar to Norbert in agronomic, disease, and malting-quality characteristics, are being evaluated in the cooperative test for wider adaptability. The gene *Un8*, for resistance to loose smut, has been transferred to improve two-row lines, and resistance to scald has been combined with resistance to stem rust and net blotch, thereby improving disease resistance.

The genetic linkage between low polyphenol content (a desirable trait in malt) and susceptibility to net blotch was broken, creating the possibility of further improvement in quality. Studies demonstrated that barley kernel hardness could not be used as an indicator of malting quality.

Common wheat

A new hard red spring wheat cultivar, Katepwa, was licensed in 1981. It is similar to the popular cultivar Neepawa, except for two extra genes for resistance to stem rust, a degree of extra resistance to leaf rust, and easier threshability. Katepwa will provide a broader base of stem rust resistance, thereby greatly reducing the probability of new races developing rapidly.

B.W. 55, a reselection of Columbus with improved seedling rust resistance, performed well in the 3rd yr of cooperative testing.

Backcrossing of sprouting resistance into the utility wheat cultivar Glenlea and into the sawfly-resistant cultivar Chester was completed, and lines were advanced for testing.

A study of R.L. 4137 dormancy in the F_1 of reciprocal crosses indicated that the seed coat or endosperm, or both, has a significant influence. The embryo component of dormancy was partially dominant.

New sources of rust resistance were identified and exploited. The gene *Lr 30* for leaf rust resistance from Terenzio was located on chromosome 4B, independent of or loosely linked with the gene *Sr7a* for stem rust resistance. Terenzio, which has gene *Lr3*, was also found to have two complementary genes, *LrT2* and *LrT3*, in common with several other cultivars.

Seedling leaf rust resistance derived from *Aegilops squarrosa* R.L. 5499 was shown to be conferred by a partially dominant gene, whereas that derived from *A. squarrosa* R.L. 5495 was due to a dominant gene. The range of resistance for the R.L. 5495 gene was reduced in the synthetic hexaploid, giving further evidence of gene suppression. The significant phenomenon of additive interactions of leaf rust genes was observed wherein intercrosses of four single-gene lines, each with only a low level of resistance, produced highly resistant selections. *Lr13* was also shown to interact with *Lr16* to enhance the level of resistance conferred by *Lr16*. Seedling resistance against a wide range of stem rust cultures, derived from the amphiploid *A. squarrosa* × *Triticum monococcum*, was shown to be conferred by two genes. A gene from *T. monococcum* (G2919) gave excellent field resistance to stem rust in both a tetraploid and a hexaploid background. The gene controlling gliadin protein band 50, as determined by polyacrylamide gel electrophoresis, was located on chromosome arm $1A^s$, and linked with the gene for hairy glume and the gene *Lr10*. Gliadin bands 26, 30, 32, 42, and 45 appear to be linked.

Durum wheat

The advanced line D.T. 433, in the cooperative test for 3 yr, produced yields that were 105 and 100% of the highest-yielding control cultivar of durum wheat in the Black and Brown soil zones, respectively. Several lines in early yield tests from populations directed at improving kernel size and yield showed yield increases of 15–20% over Coulter.

In the study of gliadin proteins, a single gene was shown to control each of electrophoretic bands 42 and 45, and glume color. A linkage value of 5–10% between the gene for bands 42 and 45 and glume color was indicated.

Oats

Two promising lines of oats were advanced to the 2nd yr in the cooperative test. They combine good yield and large seed size with excellent resistance to stem and crown rust, and loose smut. One has a tan hull color and a lower hull content; current evidence suggests a linkage of these two traits.

Preliminary results indicated that the gene *Pg-16* has been transferred from the tetraploid *Avena barbata* to the hexaploid *A. sativa* by irradiation of disomic alien addition lines and monosomic substitution lines. This gene is highly effective against all but two known races of stem rust in North America. Five new genes for resistance to crown rust were identified in three *A. sterilis* accessions.

CEREAL DISEASES

Pathology research is multifaceted, and plays an integral part in the breeding of all cereal cultivars. Annual disease surveys are conducted to determine the prevalence of races of rust and smuts; new genes for resistance to various diseases are identified and transferred to desirable germ plasm; breeders' lines are evaluated for resistance; basic studies are conducted on the biology, genetics, histochemistry, and ultrastructure of the pathogens; and long-term research is under way to explain the mechanism of host–parasite interactions and the molecular basis of resistance.

Rust surveys

Stem rust of wheat. There was less wheat stem rust in Western Canada in 1980 than in any year since observations were first regularly recorded. The disease was first observed in the eastern prairies on 12 August and was present in trace amounts in Manitoba and Saskatchewan by the end of the growing season. This was due to the highly effective resistance in commercial cultivars, limited amounts of air-borne inoculum, and adverse environmental conditions.

In 1981, stem rust was not observed until 29 July, but after that date the disease

developed rapidly, increasing to 60% on susceptible cultivars by mid-August. Clearly, 1981 was a "stem rust year" in Western Canada and only the genetic resistance in commercial cultivars protected the crop from a major loss.

Eighteen races of stem rust were identified in Canada in 1980 and most of the cultures were obtained from trap nurseries in Manitoba and eastern Saskatchewan. Races C53 (15B-1L) and C61 (38) comprised 60 and 30% of the population, respectively. Two new races were identified in 1980 but neither threatens the resistant cultivars grown in the eastern prairies.

The scope of testing for reaction to rusts was expanded from entries in the cooperative test to entries in the B and A tests, including lines from the central bread, the western bread, the nonbread, the durum, and the western durum wheat groups. The data from these tests are expected to help identify the genes present in the new cultivars as well as to ensure that cultivars recommended for the rust area have suitable resistance.

Leaf rust of wheat. Wheat leaf rust was widespread in Manitoba and eastern Saskatchewan in 1981, with the heaviest infestations occurring in eastern and central Manitoba. Early and heavy spore showers and favorable moisture conditions contributed to the rapid development of the disease. Neepawa was heavily infected but Sinton, Glenlea, Benito, and Columbus were resistant. Comparison of yields of Neepawa and Benito in crop adaptation trials at Glenlea, Man., indicate that leaf rust reduced yields by 12% at this location. Preliminary data indicate that no new races were involved in the epidemic.

Oat crown rust. Crown rust of oats was widespread in Manitoba in 1981 but the infections were light and crop losses were confined to late-seeded fields in the Red River valley. In sharp contrast, southern Ontario experienced a severe epidemic with heavy crop losses. One study in Ontario indicated losses due to crown rust of up to 60%. Preliminary results indicate no important changes in crown rust races in 1981.

Oat stem rust. Stem rust of oats was widespread in Manitoba and eastern Saskatchewan in 1981. Early spore showers and favorable environmental conditions resulted in severe infections and yield losses of up to 80% were observed by mid-August in the Red River valley and central Manitoba.

Seven races of rust were identified from field collections obtained in Eastern Canada and nine in Western Canada in 1980. The use of trap nurseries in recent years has resulted in the discovery of several new races. In total, 21 races have been identified in 600 collections from all sources representing the greatest variability ever found in the 60-yr history of oat stem rust race determinations in Canada.

Resistance to rusts

Several accessions from the world wheat collections and other sources were found to be resistant to all the races of leaf rust tested.

Five new genes for resistance to crown rust were isolated from *Avena sterilis* accessions in the Canada *Avena* collection. Six hundred new accessions from North Africa, the Canary Islands, and the Iberian Peninsula were evaluated for rust resistance. Several new diploid accessions with resistance to stem rust were identified but they will be difficult to utilize because of their lower level of ploidy.

Molecular biology and ultrastructure of cereal rusts

Extensive histochemical studies of the oat crown rust haustorial apparatus and host–pathogen interface have been completed. Much of the chemical constitution of the components was elucidated by means of periodic acid–chromate–phosphotungstate, periodic acid–thiocarbohydrazide–silver proteinate, and potassium ferricyanide staining; protease and cellulase digestion; lipid solvent extraction, binding with gold-conjugated wheat germ lectin and concanavalin A; and energy dispersive X-ray analysis. The carbohydrates, proteins, and lipids were generally concluded to be present in complex forms of glycoproteins or lipoproteins. All the possible wall layers were differentiated and a unique distribution of chitin in the fungal walls was found. Silicon, ferric pyrophosphate, and polysulfates were the major mineral elements found.

Lectin–gold particle conjugates were used as histochemical markers in determining the binding sites in spore walls, germ tube walls, and mycelium walls of wheat stem rust. Concanaval A (Con A) binding sites in spore walls and the walls of the intercellular hyphae were abolished by treatment with protease,

L1 enzyme, or a mixture of both, whereas wheat germ lectin (WGL) binding sites in these walls were not abolished by enzymes. In germ tube walls, there are no binding sites for Con A, and WGL binding sites were abolished by a mixture of protease and L1 enzyme, but not by individual enzymes. Conversely, haustorial neck walls contained Con A binding sites, but none for WGL.

The application of cryofixation and processing by freeze-substitution and freeze-etching to elucidate host–parasite relations in rusts was investigated. The first method involved structural preservation of haustoria and intracellular membranes by ultrarapid freezing without the addition of chemical fixatives. Various combinations of cryoprotectants were used to avoid ice crystallization. It appears that cryotechnology may be a key technique in physiological studies of host–parasite relations, mainly through the avoidance of chemically induced artifacts. The second method involved histochemical freeze-etching. The polyene antibiotic filipin was used to detect membrane sterols in bean rust and oat crown rust interactions. The freeze-etch replicas of filipin-treated tissues showed that the extrahaustorial membrane had a much reduced sterol content compared with normal plasmalemma-type membrane.

Five extraction methods were compared for their effectiveness in releasing macromolecular components from walls of uredosporelings of wheat stem rust. The most abundant neutral sugar in imidazole–EDTA (ethylenediamine tetraacetate), 25% NH_4OH, and 0.2 *M* NaOH extractives was mannose, whereas fucose and galactose were most abundant in Tris–trichloroacetic acid and deoxycholate extractives, respectively. *N*-Acetylglucosamine was detected only in 25% NH_4OH and 0.2 *M* NaOH extractives, yet this amino sugar was not in the eluate of Con A–Sepharose 4B column fractionation of those extractives. Con A–Sepharose 4B column eluates of all extractives contained less bound glutamic acid, glycine, and alanine but more serine, threonine, and aspartic acid than the corresponding extracts before the column elution.

RESEARCH STATION, WINNIPEG, MAN.

Smuts

Smut was observed in 82% of barley fields surveyed in Manitoba and Saskatchewan in 1981, with the cultivar Bonanza very susceptible to covered smut. A new source of resistance to loose smut of barley was identified in accessions of barley from Ethiopia.

A new race of loose smut of wheat was identified, which is virulent on the commercial durum wheat cultivars Wakooma and Coulter. The evaluation of 30 field collections from Canada, Iraq, and USSR was completed and two new races of smut were identified from USSR that are avirulent on most Canadian commercial cultivars.

An investigation of the interrelationship between loose smuts of wheat and barley, *Ustilago tritici* and *U. nuda*, showed that although their respective haplonts do fuse, there is a high degree of incompatability. Further, the host specificity of the two parental species must be conditioned by several genes because the hybrids were avirulent on both wheat and barley.

Aegilops bicornis was found to be a common host on which to hybridize the seedling-infecting *U. aegilopsidis* and the embryo-infecting *U. tritici*. This host was shown to be susceptible to all races of loose smut from either *Triticum* or *Aegilops* spp. that were tested. *Agropyron trachycaulum* and *Elymus canadensis* were identified as new hosts for *U. aegilopsidis*; and *Hordeum halophilum* and *H. euclaston*, both native to South America, were identified as new hosts for both *U. tritici* and *U. nuda*.

Foliage diseases

Leaf stripe of barley was found in 40% of all fields of two-rowed barley surveyed in Manitoba in 1981, indicating a rapid spread of the disease since its reappearance in Manitoba in 1977. Excellent control of the disease was achieved with several experimental seed dressing formulations.

When resistant barley cultivars were inoculated with net blotch (*Pyrenophora teres*) repeatedly at 24-h intervals, elevated respiration levels were maintained for several days. This reaction was similar to the response of susceptible cultivars to infection, indicating that energy redirection and lower yields may result from infection of the resistant plants.

Viruses

Barley yellow dwarf virus (BYDV) was of economic importance on cereals in southern Manitoba and southeastern Saskatchewan in 1981. The growth of cereals was retarded during June and early July; therefore, the crop was still susceptible when the aphids migrated into the area in late July. Very high populations of leafhoppers, *Macrosteles fascifrons*, vectors of aster yellows mycoplasma (AYM) and oat blue dwarf virus (OBDV), were also present. About 10% of the leafhoppers sampled from an area south of Winnipeg transmitted AYM to asters. The area of the epidemic extended from the western edge of the Red River valley to southeastern Saskatchewan.

Cytological studies of the oat tissue infected with both *Sitobion avenae*-specific and *Rhopalosiphum padi*-specific variants of barley yellow dwarf virus revealed four types of alteration patterns not previously observed with either isolate alone. These double infections also predisposed the xylem to infection. This appears to be the first report of a breakdown in tissue specifically induced by double infection with plant viruses.

Cytological studies of a virus-infected grass, *Panicum sabulorum*, from Brazil revealed alterations within cells, particularly with regard to the mitochondria and plastids, that are unique for plant-virus infections. Spherical, viruslike particles 26 nm in diameter were found in nuclei, cytoplasm, and vacuoles of xylem parenchyma cells, tracheary elements, and phloem sieve elements. Plastids and altered mitochondria, which clumped together, were also present in the cytoplasm. Changes in the mitochondria consisted of double-membraned vesicles located on the inner side of the mitochondrial envelope and connected with the cytoplasm by narrow necks.

STORED PRODUCTS PROTECTION

Research on the biology and control of pests in stored cereals and oilseeds emphasizes the interaction of insects and microorganisms in a dynamic storage environment. The program includes: studies of the ecology of stored grain; factors that limit long-term storage; identification and quantification of insects in stored products; influence of attractants and feeding stimuli on insect behavior; control of insects and mites by environmental, physical, and chemical means; and identification and control of mycotoxins in stored grain and oilseeds.

Storage ecology

Wheat and barley, delivered from the field with a range in moisture content of 12–19%, were stored in four 545-t metal bins and ventilated periodically. Weekly monitoring of variables showed no major change in the levels of O_2/CO_2 and free fatty acid, seed germination, and microflora. The moisture contents of the last samples withdrawn from the bins and used for feeding livestock were 13–16%. No adverse effect was observed when the seeds were fed to pigs and poultry, although the grain was infested with mite species such as *Cheyletus eruditus* and *Acarus* spp.

The levels of both CO_2 and O_2 and microfloral contents of wheat were measured at eight moisture levels (14–25%) at 10, 20, 30, and 40°C in an attempt to use CO_2 as an indicator of incipient grain deterioration in farm-stored grain. Regression equations were developed for each temperature to relate CO_2 to temperature, moisture content, storage time, fat acidity value, seed germination, and microflora.

In the 3rd yr of a 5-yr cooperative storage study of Random and Terra oats in farm granaries, both cultivars were infested with the mites *Lepidoglyphus*, *Blattisocius*, and *Cheyletus*; Psocoptera; and the fungi *Penicillium* and *Aspergillus* spp. In August 1981, Terra oats had an average fat acidity value of 48 as compared to 68 for Random oats.

The relations between moisture content and relative humidity and the potential for acarine and fungal infestation of *Triticale* cultivar Welch were determined at 22°C and 35–100% relative humidity (RH); at 80% RH, seed was infected by *Penicillium* spp. and *Aspergillus glaucus* group.

A low-cost ventilation system, consisting of a 560-W, 3450-r/min fan and a perforated duct, for preserving damp seed and oil quality was tested using two 34–45 t lots of rapeseed and was found to be effective in chilling and reducing the moisture content of the rapeseed by 2% while maintaining seed quality.

The distribution patterns and abundance of fungi in the cereal crops grown and stored in the Prairie Provinces were established by principal-component analyses of two sets of data. The preharvest study was based on 10

genera of fungi invading the barley crop grown in the western co-op test during 1953–1960 and the postharvest study was based on analysis of 32 fungal and other variables measured on samples from two 13-t wheat bulks over a 95-mo period.

The invasion route of three postharvest molds into rapeseeds was determined using a modified acridine orange-fluorescent staining technique. Under optimal growth conditions the fungi invaded the intact seed coats and lipid-rich aleurone and cotyledon tissues within 7 days. Some seeds were more resistant to fungal attack than others. The palisade of these seeds was more heavily lignified than that of invaded seeds. The invasion path of the spoilage mold *Aspergillus amstelodami* into the rapeseed coat was followed using electron microscopy. The fungus proliferated in the exterior mucilage, penetrated the palisade lumina, then passed into the aleurone. Evidence for possible fungal enzymatic activity was seen in several tissues. A modified substrate film technique was used to demonstrate, for the first time, the production of proteolytic enzymes by fungi invading the rapeseed coat. The electron microscopic study of palisade development in the rapeseed coat from pollination to maturity was completed. The inner tangential palisade wall and the outer tangential wall of the parenchymal cell below appeared to fuse, forming a protective layer.

Mycotoxins

The ochratoxigenic potential of 34 *Penicillium* isolates from stored cereals and oilseeds in Western Canada was determined on ground barley. Seven *Penicillium* isolates, originating from rapeseed in central Alberta and Saskatchewan, were ochratoxigenic. For the first time, *P. chrysogenum* was reported to produce ochratoxin A. Microfloral analyses were made on cereal seeds and feeds associated with suspected cases of mycotoxicosis of farm animals in the Prairie Provinces and on moist barley in ochratoxin A developmental studies.

A multivariate study was conducted to determine biological changes in wheat containing 20.5% moisture stored at 15 and 22°C. Temperature effects were significant for moisture content, O_2/CO_2 balance, microfloral abundance, fat acidity values, ochratoxin A levels, and degree of infection by *Alternaria alternata*, *Aspergillus versicolor*, and bacteria. Limited analytical facilities were provided to the Grain Inspection Division, Canadian Grain Commission. Wheat suspected of containing *Fusarium* trichothecenes was analyzed for T-2 toxin, deoxynivalenol, and diacetoxyscirpenol and found negative, allowing the grain to be shipped. In addition, limited analytical services were extended to the departments of agriculture in Manitoba, Saskatchewan, and British Columbia. Samples of confection-grade Manitoba sunflower seeds, previously reported as containing aflatoxins by commercial analysts, were found aflatoxin-free by fluorescence liquid chromatography. Ochratoxin A at levels of 48 μg/kg were detected in a feed sample associated with bovine abortion in Saskatchewan.

Biology

Studies on the biology of the larger grain borer, *Prostephanus truncatus* (Horn), showed that the insect is unlikely to become established in Canada because of its inability to breed on stored cereals. Two cultivars of each of four cereals, barley, oats, durum wheat, and red spring wheat, grown at Glenlea in 1980 were tested with the flour beetle assay 2 and 6 mo after harvest to determine changes in nutritional value with time. Harmon oats and Bonanza barley ranked first and second, respectively, in both tests. Larval development was 1.3–3.7 days longer on the durum and red spring wheats in the 6-mo than in the 2-mo tests.

A logistic equation described the relationship between mean developmental rate and temperature for each of three cereal diets. The effect of diet was greatest at the optimal temperature for development. A coefficient *K* was highly correlated with the lysine content of the diet and may be used quantitatively to summarize interactions of environmental factors.

The flour beetle *Tribolium madens*, previously considered not to occur in Canada, is now being reported with increasing frequency. It was found in more than 100 boxcars in Eastern Canada between January and September 1981. This species and the closely related *Tribolium audax* are being reared at the Winnipeg Research Station in anticipation of possible future experiments on biology, behavior, and control if either or both species become established in Canada. A report of *T. madens* in a boxcar at Winnipeg on 3 August 1979 is apparently a first record for Canada.

The sampling of insects for a study of insect distribution in empty granaries in Manitoba was completed in 1981. A satisfactory method of selecting farms for sampling was developed and a total of 544 samples were collected on 76 farms in Manitoba. Preliminary examination indicated that *Cryptolestes ferrugineus*, *Tenebrio molitor*, *Pyralis farinalis*, and *Tribolium audax* were widely distributed in the grain-growing region of Manitoba.

A preliminary analysis of data obtained from 5000 samples of grain taken from boxcars in 1977 and 1978 showed that about 1.5% contained adults and 3.0% contained larvae of *C. ferrugineus*. Data were collected on the type of grain as well as its temperature and moisture content in each boxcar sampled. Fourteen kinds of arthropod pests were included in the preliminary analysis.

Control

The occurrence of high insecticide residues in rapeseed stored in a wooden granary treated at the recommended rate suggests that current methods of insecticide application should be modified to reduce the risk of residues in grain that is to be protected from infestation. Since insecticide uptake by stored grain has been shown to depend on the type of floor surface and the kind of grain, new methods that employ spot treatments of infested granaries and the use of insecticide-impregnated substrates, developed at this station, should be field tested.

Assessment of a survey questionnaire on insecticide usage in flour mills, feed mills, and terminal elevators revealed that malathion is the most widely used insecticide in all facilities. Liquid fumigants are used in flour mills and feed mills, and tablets or pellets of aluminum phosphide are used mainly in elevators.

Rusty grain beetle (*C. ferrugineus*) adults and eggs, and the mite *Lepidoglyphus destructor*, tolerated very high concentrations of nitrogen. It would appear, therefore, that this gas has little value as a practical fumigant.

In a collaborative study, the survival of adult and immature *C. ferrugineus* in wheat dried with hot silica sand was investigated. Complete mortality of all stages was obtained when hot sand was mixed with wheat in a batch drier. In a continuous-flow drier, adult mortality was 100% whereas the mortality of immature stages ranged from 94.7 to 97.5% when two-stage drying was conducted at 105°C or one-stage drying at 115°C, compared with 11.4–29.0% when one-stage drying was conducted at 105°C.

In another collaborative study, wheat treated with fenitrothion at 0.8 mL/kg was stored at seven temperatures from −35 to 27°C for up to 72 wk. Residues decreased with increasing temperature. At 72 wk, degradation was 18, 35, 56, 90, and 96% at −5, 5, 10, 20, and 27°C, respectively.

CROP PROTECTION

Research on insect pests of oilseed and field crops emphasizes the development and implementation of better methods of pest management to avoid or reduce damage. The program includes field testing insecticides, developing and testing techniques for monitoring and predicting pest abundance and crop damage, and investigating methods of improving nonchemical control of pests. These programs are supported by research on sampling techniques, survival, development, phenology, host selection, induction and termination of diapause, overwintering strategies, reproductive biology, and biochemical bases of neurotransmission.

Monitoring and prediction

In 1981, about 16 200 ha were sprayed in Manitoba to control grasshoppers, a decrease of about 14 000 ha from 1980. The survey conducted in the fall of 1981 indicates that the area of grasshopper infestations in Manitoba will increase slightly but the density of populations will be lower. Infestations will occur again in the south-central portion of the province, from Gladstone and Neepawa to the Assiniboine River, along the eastern side of the Red River from Isle de Chene to the international boundary, and west of the Red River south and west of Winnipeg. These infestations should be light with a few small areas of moderate infestations. The twostriped grasshopper, *Melanoplus bivittatus*, was the dominant species in the Red River valley whereas the clearwinged grasshopper, *Camnula pellucida*, predominated elsewhere.

The methods of predicting outbreaks of the bertha armyworm, *Mamestra configurata*, gave an early and accurate warning to farmers. The catch of male moths in sex-attractant traps predicted the continuation of an outbreak in the Swan River valley and the collapse of the outbreak in the Dauphin area.

In 1981, 5680 ha were sprayed in the Swan River valley, more than twice the area sprayed in 1980. An intensive study of 15 rape fields near Durban, utilizing sex-attractant traps and larval sampling, showed that the number of moths caught in the traps is affected by the synchronization of crop development and the flight period of the bertha armyworm. Rape crops appear to attract the most moths, and subsequently have the highest larval densities, if the peak moth flight occurs soon after the flowers open.

Sex-attractant traps baited for the clover cutworm, *Scotogramma trifolii*, the redbacked cutworm, *Euxoa ochrogaster*, and the glassy cutworm, *Crymodes devastator*, were placed in zero-tillage fields at 10 locations in Manitoba. The clover cutworm was most abundant in the Red River valley and catches of the redbacked cutworm were moderately high at all locations south of Dauphin. The glassy cutworm was not abundant at any of the locations. A comparison of catches of cutworm moths in light traps located in a field under regular cultivation and one under zero tillage showed 51 species in zero tillage and 41 species with regular tillage. This difference was mainly caused by minor species of no agricultural importance. Of the seven species that produced 100 or more moths, six were the same in each area.

Damage assessment

Aerial spraying of bertha armyworm saved an estimated 10, 4, and 0% of the potential crop yield in three fields under test. The best results from spraying occurred when the spray was applied before pod feeding began. Prespray sampling of 42 fields slated for spraying indicated that only 5 were likely to realize a significant cost-benefit from spraying and another 6 would realize marginal savings that would pay for the spraying, whereas the remaining 31 would lose money. Uneconomic spraying was related mainly to delays in applying the spray, allowing most of the yield loss to occur before spraying. In addition, some fields with noneconomic infestations were sprayed.

An analysis of the economics of insecticidal control of flea beetles, *Phyllotreta* spp., attacking rape in Western Canada indicated that in 1979 about $12 million was spent for insecticidal applications. These control measures prevented the loss of about 5% of the canola production, worth about $44 million. Despite these control measures, flea beetles caused an estimated loss of at least 8% of total production.

Insecticides

Numerous insecticides were tested for the control of flea beetles on rape, alone or in combination with fungicides or other insecticides, and at different rates of application as in-furrow granules, seed dressings, or foliar sprays. Measurements made to evaluate the effectiveness of the products and the response of the plants tended to verify previous findings. Results of bioassays on flea beetle control, in general, showed a good correlation with seedling damage, subsequent plant development, vigor, and seed yield. Most of the products tested provided control during the period of seedling emergence, but only the in-furrow granular treatments provided the persistence or duration of control necessary for a positive yield response. Tests in 1981 verified previous results that insecticides, particularly in-furrow granulars, applied at seeding for the control of flea beetles on rape, are less effective when used with a discer seeder than with a seed drill.

Based mainly on data from this project, terbufos, an organophosphate insecticide, was registered during the year for use as an in-furrow granular treatment for the control of flea beetles on rape in Canada. This is important in that it provides an alternative to carbofuran, a carbamate, which has been the only insecticide in granular formulation registered for use against flea beetles on rape. Seed yield of rape treated with terbufos was about 20% greater than that of the control, 15% greater than that of rape treated with lindane, and equal to that of rape treated with carbofuran.

A number of insecticides, including several synthetic pyrethroids, have been shown to be effective as foliar sprays against the sunflower beetle on sunflowers, as have several systemic insecticides when applied as in-furrow granulars with small-plot equipment. The granulars have a greater potential for season-long control of the sunflower beetle than do foliar sprays, but a suitable method for commercial application is yet to be developed.

Foliar sprays of several insecticides of different classes were shown to be effective against the Colorado potato beetle. However, reinfestation of plants by larvae within a short time of initial knockdown, particularly with

RESEARCH STATION, WINNIPEG, MAN.

the synthetic pyrethroids, suggests that the rates of application indicated by the manufacturers are too low.

Biological control

Attempts to establish the European parasite *Microctonus bicolor*, which attacks the rape-feeding flea beetles, were continued. A total of 578 adults of *M. bicolor*, plus 3420 flea beetles that had been exposed to female parasites in the laboratory, were released at Glenlea during July–September 1981. No evidence of establishment of this parasite was obtained from large numbers of flea beetles that were collected in the release area.

A potentially useful parasite of the bertha armyworm, *Mamestra configurata*, was identified through study of literature on parasitism of the cabbage moth, *M. brassicae*, in the USSR. A tachinid, *Ernestia consobrina*, is the most successful parasite in the cooler parts of the Soviet Union where the life history of the cabbage moth is similar to that of bertha armyworm in Canada. In addition, no effective native parasite has a life history similar to that of *E. consobrina*.

Plant resistance

A method for screening lines of *Brassica* spp. for resistance to flea beetle attack was refined and 94 lines submitted by plant breeders were screened. Much variation within and among species in plant survival, biomass production, and seed yield was identified. Midas, a cultivar of *B. napus*, was found to produce three times the yield of currently recommended cultivars when exposed to heavy flea beetle attack without insecticidal protection. An assessment also was made of 523 lines in a crucifer garden at the University of Manitoba and 20 lines were identified as being less susceptible than any of the *B. napus* lines in the main screening program.

Natural control

Native parasites and diseases of bertha armyworm destroyed a significant portion of the larval population in 1981. In the outbreak areas, parasitism averaged 36%, mainly by *Banchus flavescens*, and a nuclear polyhedrosis disease killed 41%. In fields with low populations the parasitism was higher, 57%, but disease killed only 16% of the larvae.

Experiments to determine the effect of exposure to low temperatures on the survival of pest insects continue. The light snowfall in the Dauphin area during the winter of 1980–1981 reduced survival of bertha armyworm pupae in cultivated fields to only 2%. Survival in comparable fields with at least 10 cm of snow varied from 9 to 46%. Pupal survival in uncultivated portions of the same fields averaged 37%.

The number of flea beetle adults that overwinter in the riverbank forest along the Red River has declined since the winter of 1979–1980. This appears to coincide with light snow cover and low temperatures during the early part of the winters of 1980–1981 and 1981–1982.

Overwintering eggs of the red turnip beetle, *Entomoscelis americana*, showed no mortality after 200 days of exposure to −5 and −10°C. Survival was 58% at 0°C and 73% at −15°C, but no eggs survived for 200 days at −20°C.

Diapause

Diapause-programmed larvae of *M. configurata* were treated with sublethal doses of an organochlorine (DDT), organophosphate (malathion), formamidine (chlordimeform), and synthetic pyrethroid (permethrin), and the incidence of diapause was determined. Each of the insecticides disrupts nervous system function in a specific way that possibly could be correlated with brain function and diapause induction. None of the insecticides had an antidiapause action. Based on these and other results, it appears that the search for antidiapause compounds is unlikely to be profitable until further progress is made in identifying the neurochemical basis of diapause induction.

Experiments were conducted to determine whether free, bound, and total cyclic adenine monophosphate (cAMP) in pupal brains were involved in the initiation of postdiapause development. Results indicated that cAMP is not involved in the transduction of photoperiodic signals in *M. configurata* but is involved with brain differentiation.

Diapause could not be induced in any developmental stage of the variegated cutworm, *Peridroma saucia*. Because the most cold-hardy stage, the pupa, could survive only 6 wk at 0°C and only 2 wk at −2°C, it is unlikely that this pest cutworm can overwinter in Manitoba.

Pest management systems

Results of research on the red turnip beetle have led to the development of a management system for minimizing damage caused by this pest. Populations can be reduced to a very low level by the combination of fall tillage to destroy eggs and the control of cruciferous weeds and volunteer rape in the spring to eliminate food for the larvae. The feeding of adult beetles was shown to have no effect on crop yields.

PUBLICATIONS

Research

Antorm, M. D.; Abramson, D.; Tyson, R. L.; Chang, C. J.; McLaughlin, J. L.; Peck, G.; Cassady, J. M. 1981. Potential antitumor agents XVII. Physalin B and 25,26-epidihydrophysalin C from *Witheringia coccoloboides* (Solanaceae). J. Nat. Prod. 44:579-585.

Barker, P. S. (1978) 1981. Control of adult rusty grain beetles, *Cryptolestes ferrugineus* (Stephens) with carbon disulphide at temperatures between 6.6 and 10°C, and estimation of the dosage applied. Manit. Entomol. 12:35-41.

Barker, P. S. (1978) 1981. The responses of eleven strains of *Tribolium castaneum* (Herbst) to methyl bromide. Manit. Entomol. 12:29-34.

Bodnaryk, R. P. 1981. Developmental changes in brain taurine levels during metamorphosis of the moth, (*Mamestra configurata* Wlk.). Insect Biochem. 11:9-16.

Bodnaryk, R. P. 1981. Free and bound cyclic AMP in the brain of the moth *Mamestra configurata* Wlk. during pupal–adult metamorphosis. Can. J. Zool. 59:1629-1634.

Bodnaryk, R. P. 1981. The biosynthesis, function and fate of taurine during the metamorphosis of the noctuid moth, *Mamestra configurata* Wlk. Insect Biochem. 11:199-205.

Brown, P. D.; McKenzie, R. I. H.; Mikaelsen, K. 1980. Agronomic, genetic, and cytologic evaluation of a vigorous new semidwarf oat. Crop Sci. 20:303-306.

Bucher, G. E. 1981. Identification of bacteria found in insects. Pages 7-33, Chap. 2, *in* Burgess, H. D., ed. Microbial control of pests and plant diseases 1970–1980. Academic Press, London.

Bucher, G. E.; Lamb, R. J.; Bracken, G. K. 1981. Temperature profiles in a rape field before and after harvest. Can. J. Soil Sci. 61:145-156.

Campbell, A. B. 1981. Napayo hard red spring wheat. Can. J. Plant Sci. 61:143.

Campbell, A. B.; Czarnecki, E. M. 1981. Benito hard red spring wheat. Can. J. Plant Sci. 61:145-146.

Campbell, A. B.; Czarnecki, E. M. 1981. Columbus hard red spring wheat. Can. J. Plant Sci. 61:147-148.

Chong, J.; Harder, D. E. 1980. Ultrastructure of haustorium development in *Puccinia coronata avenae* I. Cytochemistry and electron probe X-ray analysis of the haustorial neck ring. Can. J. Bot. 58:2496-2505.

Chong, J.; Harder, D. E.; Rohringer, R. 1981. Ontogeny of mono- and dikaryotic rust haustoria. Cytochemical and ultrastructural studies. Phytopathology 71:975-983.

Demianyk, C.; Sinha, R. N. 1981. Effect of pyralid moth infestation on fat acidity, seed germination, and microflora of stored wheat. J. Econ. Entomol. 74:526-531.

Dexter, J. E.; Matsuo, R. R.; Kosmolak, F. G.; Leisle, D.; Marchylo, B. A. 1980. The suitability of the SDS-sedimentation test for assessing gluten strength in durum wheat. Can. J. Plant Sci. 60:25-29.

Dyck, P. L.; Kerber, E. R. 1981. Aneuploid analysis of a gene for leaf rust resistance derived from the common wheat cultivar Terenzio. Can. J. Genet. Cytol. 23:405-409.

Gerber, G. H. 1981. Cold-hardiness in the eggs of the red turnip beetle, *Entomoscelis americana* (Coleoptera: Chrysomelidae). Can. Entomol. 113:795-800.

Gerber, G. H. (1978) 1981. Effects of burying the eggs in soil on survival in the red turnip beetle, *Entomoscelis americana* (Coleoptera: Chrysomelidae). Manit. Entomol. 12:49-51.

Gerber, G. H.; Obadofin, A. A. 1981. The suitability of nine species of Cruciferae, as hosts for the larvae of the red turnip beetle, *Entomoscelis americana* (Coleoptera: Chrysomelidae). Can. Entomol. 113:407-413.

Gerber, G. H.; Obadofin, A. A. 1981. Growth, development, and survival of the larvae of the red turnip beetle, *Entomoscelis americana* (Coleoptera: Chrysomelidae), on *Brassica campestris* and *B. napus* (Cruciferae). Can. Entomol. 113:395-406.

Gill, C. C.; Chong, J. 1981. Vascular cell alterations and predisposed xylem infection in oats by inoculation with paired barley yellow dwarf viruses. Virology 114:405-413.

Gill, C. C.; Chong, J.; Caetano, V. R. 1981. Cytopathological alterations in mitochondria associated with virus-like particles in *Panicum sabulorum*. Can. J. Plant Pathol. 3:129-135.

Green, G. J. 1980. Physiologic races and epidemiology of *Puccinia graminis* on wheat, barley and rye in Canada in 1979. Can. J. Plant Pathol. 2:241-245.

Green, G. J. 1981. Identification of physiologic races of *Puccinia graminis* f. sp. *tritici* in Canada. Can. J. Plant Pathol. 3:33-39.

Harder, D. E. 1980. Virulence and distribution of *Puccinia graminis avenae* in Canada in 1979. Can. J. Plant Pathol. 2:249-252.

Kader, M. H. K.; Webster, G. R. B.; Loschiavo, S. R.; Watters, F. L. 1980. Low temperature degradation of malathion in stored wheat. J. Econ. Entomol. 73:654-656.

Kosmolak, F. G.; Dexter, J. E.; Matsuo, R. R.; Leisle, D.; Marchylo, B. A. 1980. A relationship between durum wheat quality and gliadin electrophoregrams. Can. J. Plant Sci. 60:427-432.

Kosmolak, F. G.; Dyck, P. L. 1981. Milling and baking qualities of ten spring wheat cultivars from the People's Republic of China. Cereal Chem. 58:246-247.

Kosmolak, F. G.; Kerber, E. R. 1980. Marquis-K cultivar standard for wheat gliadin electrophoresis. J. Sci. Food Agric. 31:1250-1252.

Kosmolak, F. G.; Larson, R. I.; McKenzie, H. 1980. Milling and baking quality of Rescue-Cadet reciprocal substitution lines. Can. J. Plant Sci. 60:1333-1341.

Lamb, R. J. 1980. Hairs protect pods of mustard (*Brassica hirta* 'Gisilba') from flea beetle feeding damage. Can. J. Plant Sci. 60:1439-1440.

Lamb, R. J. 1980. The rise and decline of a local population of the aphid, *Aphis barberae* Robinson (Homoptera: Aphididae). Can. Entomol. 112:1285-1289.

Lamb, R. J.; Loschiavo, S. R. 1981. Diet, temperature, and the logistic model of developmental rate for *Tribolium confusum* (Coleoptera: Tenebrionidae). Can. Entomol. 113:813-818.

Lamb, R. J.; Smith, S. M. 1980. Comparison of egg size and related life-history characteristics for two predaceous tree-hole mosquitoes (Toxorhynchites). Can. J. Zool. 58:2065-2070.

Lau, R. H. F.; Reid, J.; Kim, W. K. 1981. Virus-like particles in *Alternaria tenuis*. Mycologia 73:97-104.

Leisle, D.; Kosmolak, F. G.; Kovacs, M. 1981. Association of glume color with gluten strength and gliadin proteins in durum wheat. Can. J. Plant Sci. 61:149-151.

Martens, J. W. 1980. Incidence and virulence of *Puccinia graminis* f. sp. *avenae* in Canada in 1979. Can. J. Plant Pathol. 2:253-255.

Martens, J. W.; McKenzie, R. I. H.; Harder, D. E. 1980. Resistance to *Puccinia graminis avenae* and *P. coronata avenae* in the wild and cultivated *Avena* populations of Iran, Iraq and Turkey. Can. J. Genet. Cytol. 22:641-649.

McKenzie, R. I. H.; Brown, P. D.; Martens, J. W.; Mallough, E. D. 1981. Registration of Terra oats. Crops Sci. 21:633.

McKenzie, R. I. H.; Martens, J. W.; Brown, P. D.; Harder, D. E.; Nielsen, J.; Boughton, G. R. 1981. Registration of Fidler oats. Crop Sci. 21:632-633.

Mensah, G. W. K.; Watters, F. L. 1981. Effects of abrasion on the persistence of malathion, bromophos, and iodofenphos deposits on plywood surfaces. J. Econ. Entomol. 74:65-66.

Metcalfe, D. R.; Bendelow, V. M. 1981. Norbert barley. Can. J. Plant Sci. 61:1005-1007.

Mills, J. T.; Abramson, D. 1981. Microflora and condition of flood-damaged grains in Manitoba, Canada. Mycopathologia 73:143-152.

Samborski, D. J. 1980. Occurrence and virulence of *Puccinia recondita* in Canada in 1979. Can. J. Plant Pathol. 2:246-248.

Sinha, R. N.; Mills, J. T.; Wallace, H. A. H.; Muir, W. E. 1981. Quality assessment of rapeseed stored in ventilated and nonventilated farm bins. Science des Aliments 1:247-263.

Starratt, A. N.; Bodnaryk, R. P. 1981. Stereoisomeric identity of octopamine in the central nervous system of invertebrates. Insect Biochem. 11:645-648.

Thomas, P. L. 1981. Distinguishing between the loose smuts of barley. Plant Dis. 65:834.

Thomas, P. L.; Nielsen, J.; Kirby, G. C. 1981. Infection of *Bromus unioloides* by *Ustilago avenae* and *Ustilago kolleri*. Australas. Plant Pathol. 10:25-27.

Wallace, H. A. H.; Sinha, R. N. 1981. Causal factors operative in distributional patterns and abundance of fungi: A multivariate study. Pages 233-247, Chap. 13, *in* Wicklow/Carroll, eds. The fungal community. Marcel Dekker, Inc., New York.

White, N. D. G.; Sinha, R. N. 1981. Energy budget for *Oryzaephilus surinamensis* (Coleoptera: Cucujidae) feeding on rolled oats. Environ. Entomol. 10:320-326.

Wylie, H. G. 1981. Effects of collection method on estimates of parasitism and sex ratio of flea beetles (Coleoptera: Chrysomelidae) that infest rape crops in Manitoba. Can. Entomol. 113:665-671.

Miscellaneous

Kim, W. K.; Rohringer, R. 1981. Sugar and amino acid compositions of macromolecules from germ tube walls of wheat stem rust. Proc. 13th Int. Bot. Congr., Sydney, Australia. p. 157.

Kim, W. K.; Rohringer, R.; Howes, N. K.; Chong, J. 1981. Approaches for the detection of the products of genes for resistance and avirulence in the wheat/stem rust system. Proc. Int. Symp. on the new frontiers and future perspectives of plant biochemistry, Nagoya, Japan. pp. 68-70.

Mittal, G. S.; Smith, L. B.; Lapp, H. M. 1981. Thermal disinfestation of wheat with solid heat transfer medium. Agric. Mech. Asia Afr. Lat. Am. 12:53-56.

Muir, W. E.; Fraser, B. M.; Sinha, R. N. 1980. Simulation model of two-dimensional heat transfer in controlled-atmosphere grain bins. Pages 385-398 *in* Shejbal, J., ed. Controlled atmosphere storage of grains. Elsevier Scientific Publishing Co., Amsterdam.

Nielsen, J. J. 1981. Loose smut of wheat. Canadex 112.630.

Nielsen, J. J. 1981. Loose smut and covered smut of oats. Canadex 113.630.

Thomas, P. L. 1981. Covered smut and false loose smut of barley. Canadex 114.630.

Thomas, P. L. 1981. Loose smut of barley. Canadex 114.630.

Research Station
Melfort, Saskatchewan

PROFESSIONAL STAFF

S. E. Beacom, B.Sc., M.Sc., Ph.D.	Director
W. J. Peperkorn	Office Manager
D. J. Ewanus, B.Sc.	Farm Manager

Forage Production and Utilization

J. A. Robertson, B.Sc., M.Sc., Ph.D.	Program Leader; Beef cow management, harvesting systems evaluation
S. E. Beacom, B.Sc., M.Sc., Ph.D.	Utilization of harvested forages
S. Bittman, B.Sc., M.Sc.	Forage crop production
E. Z. Jan, B.Sc., M.Sc., Ph.D.	Forage harvesting systems
D. H. McCartney, B.Sc., M.Sc.	Beef cow management systems
J. Waddington, B.Sc., M.Sc., Ph.D.	Forage ecology and weed control
Vacant	Ruminant nutrition, forage utilization

Cereal, Oilseed, and Special Crop Production and Utilization

K. E. Bowren, B.S.A.	Program Leader; Crop production
W. F. Nuttall, B.S.A., M.Sc., Ph.D.	Soil fertility
Vacant	Crop evaluation and agronomy

INTRODUCTION

Scientists at the Melfort Station are responsible for developing more efficient forage production, harvesting, and utilization systems that are designed to provide beef cattle producers with an alternative to expensive feed grains and to encourage greater use of forage crops in rotations, in the interest of better land management. They are also involved in the improvement of production efficiency of cereal, oilseed, and special crops and the development of efficient cow–calf management systems in the northern park belt.

During 1981, research was carried out on energy requirements of the components of the forage system, calf scours, development of a large round bale unroller to permit feeding into a standard grinder mixer, remote sensing of pasture productivity, and the application of herbicides to brush regrowth on pasture. This work was made possible through research contracts; Energy, Mines and Resources Canada; Alberta Heritage Trust Fund; and a Summer Job Corps project.

Brief summaries of some of our work are presented here. For more information, readers may obtain a copy of our Research Highlights 1981 by writing to the Research Station, Research Branch, Agriculture Canada, Box 1240, Melfort, Sask. S0E 1A0, by telephoning (306) 752-2776, or by Telex 074-29122.

S. E. Beacom
Director

FORAGE PRODUCTION AND UTILIZATION

Winter survival of alfalfa

Alfalfa losses during the winter of 1980–1981 were much more severe than they had been for several previous winters. The cause was the unusually low soil temperatures (–22°C at 5-cm depth) in December shortly after a snow cover had melted. The variety Rambler, with 10% of plants killed, proved to be more hardy than the varieties Beaver and Anchor, which had 46 and 51%, respectively, of plants killed. Varieties cut for the second harvest on 15 August had an average of 6% plants dead the next spring. Harvests on 29 August or later caused 39–46% winterkill. All varieties responded in the same way to the various fall cutting dates; Rambler had less winter damage after each harvest date than had Beaver or Anchor.

Polish rapeseed as a companion crop for establishing forages

The legumes established with Polish rapeseed (*Brassica campestris* L.) yielded only 60% of the forage produced when they were established alone. Grasses established with rape produced 70% of the yield obtained when they were established alone. Volunteer rape was a severe problem in the year following establishment, particularly with sainfoin and Russian wild rye which were poor competitors. Sainfoin was not long lived, and the plots became very weedy by the third harvest year. Russian wild rye also was not competitive and yielded poorly under the conditions of one cut per year.

Yield and quality of oats and oilseed radish

When grown at Melfort in 1981, both oats and oilseed radish (*Raphanus sativus* L. var. *oleiferus*) produced dry matter yields of 5500 kg/ha. Oats contained 22% dry matter, 12.5% crude protein, 56% neutral detergent fiber, and 8.6% ash. Radish contained 11% dry matter, 18.8% crude protein, 35% neutral detergent fiber, and 13% ash. Both crops had similar amounts of acid detergent fiber. Two potential problems when using radish as a forage are apparent: the very low dry matter content of the plant poses difficulties when it is preserved as hay or silage, and the high protein content may have high nitrate associated with it.

Mineral concentrations in pasture herbage

Five minerals—sodium, calcium, magnesium, phosphorus, and copper—were found to be at deficient or marginal levels in all pastures in northeastern Saskatchewan on the basis of herbage samples collected in 1979 and 1980. Zinc was low at one site and

selenium marginal at two sites. Molybdenum levels were high. The effect of low copper intake by ruminants (4–7 mg/kg compared with a requirement of 6–10 mg/kg) may be aggravated by high intake of molybdenum, which interferes with copper absorption and utilization. Molybdenum levels greater than 5 mg/kg and molybdenum-to-copper ratios greater than 0.5 are considered undesirable. In this study, molybdenum levels ranged between 3 and 8 mg/kg with molybdenum-to-copper ratios between 0.5 and 1.5.

Effects of soil-applied herbicides on alfalfa seed production and nectar flow

In early spring of each of the years 1978–1981, the herbicides metribuzin (4-amino-6-*tert*-butyl-3-[methylthio-as-triazine-5(4*H*)one]); metribuzin plus terbacil (3-*tert*-butyl-5-chloro-6-methyluracil); velpar [3-cyclohexyl-6-(dimethylamine)-1-methyl-*s*-triazine-2-4(1*H*,3*H*)-dione]; and velpar plus terbacil were applied to established alfalfa. Seed yields were not increased significantly in the first 2 yr. In 1980, treated areas produced approximately twice as much seed as the untreated control areas, and in 1981, seed yields from treated alfalfa were two or three times that of the control. The most productive areas had been treated with metribuzin at 1.6 kg/ha. Yields of the control in 1980 and 1981 were 130 and 100 kg/ha, respectively. In 1980, none of the herbicides had any effect on nectar production during the pollination season.

Melfort hay tower system

After a decade of development, the Melfort hay tower system has become an efficient, practical unit for drying and storing excellent-quality hay. The tower is 7.6 m in diameter and 12.2 m high. It holds 57 t of brome–alfalfa or 73 t of alfalfa. The one-man system permits hay to be put in at 30–40% moisture and dried with a high-capacity fan. Drying costs are in the range of $3–$6/t depending upon the moisture content, the kind and length of chop of the hay, the amount of hay put in, weather conditions, and the length of filling time. The dry hay is easily unloaded into self-unloading feeding wagons or a grinder-mixer.

Fuel requirements to grind hay

Grinding dry (11% moisture) alfalfa hay, using a 75-kW tractor and a Model 1260 Bearcat grinder-mixer, required about 7.3 L of diesel fuel per tonne of dry hay when using screens with 7-, 10-, and 13-mm diameter openings. At a moisture content of 13%, fuel consumption rose to 12.5, 11.5, and 8.6 L/t when using the 7-, 10-, and 13-mm screens, and at 18% moisture, rose to 34.6, 23.3, and 11.0 L/t, respectively. At the higher moisture content, screens became clogged with fibrous material. Capacity was reduced from 3.48 t/h at 11% moisture to as little as 1.20 t/h when the 18% moisture hay was ground through the 7-mm screen. The importance of putting up and storing hay at a low moisture content when it is used to prepare ground rations is indicated.

Finishing steers and heifers on ground high-forage rations

Ammoniating straw. Adding 3% anhydrous ammonia to ground barley straw (crude protein 4.2%, digestible organic matter 42%, dry matter 80%) in an insulated bin increased crude protein to 14% and digestible organic matter to 55%, 10 days after treatment. However, replacing part of the ground, good-quality alfalfa hay in a finishing ration for steers and heifers with ground straw (25%) or ammoniated straw (25 or 35%) markedly reduced rate of gain (12–40%), feed efficiency (2–47%), dressing percentage (1–3.4 percentage units), and returns per head ($39–$92), with heifers more adversely affected than steers and ammoniated straw more detrimental than untreated straw.

Monensin. Data from 3 yr, involving nine separate comparisons and 144 steers (all implanted), were averaged. The addition of monensin (Rumensin) at recommended levels to ground-hay finishing rations fed to steers for an average feeding period of 113 days reduced rate of gain by 5% ($P < 0.01$), dressed carcass weight by 2%, and returns per head by $11.

Acidulated fatty acids (AFA). Supplementation of ground, good-quality hay rations with 3, 4, and 5% AFA (from rapeseed) increased rate of gain of finishing steers by 6.2, 13.6, and 7.8%, improved feed efficiency by 3.5, 11.7, and 9.3%, and increased returns per head by $4.43, $15.61, and $13.92,

respectively, when AFA was priced at approximately 35¢/kg.

Growth implants. On both forage- and grain-based rations, steers implanted with Synovex S gained 11–13% faster and 11–15% more efficiently, and returned $20 to $40 more than comparable steers implanted with Ralgro. Heifers fed the grain-based ration gained faster and more efficiently when implanted with Synovex H, whereas on the forage-based ration, gains and feed efficiency were better for those implanted with Ralgro. However, returns on both rations were higher for heifers implanted with Synovex.

Implanting and grain supplementation of steer calves fed barley silage

Addition of barley grain to a diet of whole-plant barley silage increased rate of gain across treatments by an average of 0.21 kg/head (22%) and improved feed efficiency by 11%. Ralgro and Synovex S implants also improved rate of gain and feed efficiency, although Synovex S was more effective than Ralgro (14.6 versus 7.6% and 11.7 versus 9.3%, respectively). Implanting was more beneficial when used in conjunction with the ration supplement.

Cow–calf management systems

Fertilized rough land pastures, over the past 3 yr, have produced extra calf gains of 25.5 kg/ha compared with nonfertilized control fields, enough to pay for the actual fertilizer costs of $35/ha (1980 prices). The 5-yr average length of grazing season was 138.4 days for the four-field system, 148.2 days for the six-field (reseeded) systems, and 120.3 days for nonfertilized control fields. The reseeded six-field rotational systems supported 116 animal-days per hectare, whereas the four-field rotational system and nonfertilized, continuously grazed controls carried 111 and 83 animal-days, respectively.

During the 1981 calving season, 22% of calves (or 66 animals) were born between 12:00 a.m. and 6:00 a.m., 44% (or 134) between 8:00 a.m. and 8:00 p.m., and 56% (168) between 8:00 p.m. and 8:00 a.m. Cows that calved in January–February ate 5.2% more feed dry matter during the drylot phase than cows that calved in April and early May. After summer grazing, early-calving Angus cows had 7.6 mm of fat and weighed an average of 517 kg, whereas late-calving Angus cows had 6.67 mm fat and weighed 461 kg. Early-calving Simmentals had 3.4 mm of fat and weighed 531 kg compared with 2.79 mm of fat and a weight of 517 kg for the late-calving cows.

PRODUCTION AND UTILIZATION OF CEREALS AND SPECIAL CROPS

Cereal and oilseed cultivar testing

A new cultivar of hard red spring wheat, Columbus, yielded 10% more than Neepawa, the common cultivar grown in the area, but was about 2 days later during the 1978–1981 period. Columbus has superior weathering resistance during harvest, which is important to producers in the area.

Klages, a two-row malting barley, outyielded Bonanza by 5% on the basis of 12 test means at three locations in the area from 1978 to 1981. It is 6 days later in maturity but has a higher volume weight. New lines, TR 441 (Harrington), 451, and 446, bred from Klages crosses, outyielded Klages at three sites in 1981.

Andor, a new 0-0 *B. napus* rapeseed, outyielded Regent by 2% at Melfort over 3 yr and was 3 days earlier in maturity.

A silage corn selection, R102, produced an average dry matter yield of 11.6 t/ha from 1973 to 1980, with an average dry matter content of 35.6% at harvest. Due to the drought in 1981, yields were lower than normal (5.6 t/ha). However, with the long open fall, dry matter contents were high and some new hybrids yielded up to 4000 kg/ha (14% moisture) of grain that had less than 30% moisture at harvest and weighed over 72 kg/hL.

Effect of sulfur and boron on yield of canola

Fields of canola that did not set seed were grown on soils found to be deficient in sulfur (S) and boron (B). Application of S and B corrected the deficiency, but response to S and B was inconsistent from year to year. With N, P, and S applied at 100, 20, and 50 kg/ha, respectively, average yields of Candle and Regent canola over 2 yr (1980-1981) were 1250 and 1650 kg/ha. The addition of S, S plus B, and B alone resulted in yields of 1376, 1437, and 1400 kg/ha for Candle and 1941, 2031, and 1887 kg/ha for Regent, respectively. Maximum yield increase from S was

578 kg/ha and maximum increase from B was 567 kg/ha, for Regent canola grown in 1981.

Weed control in cereal crops

Three new herbicides, DPX 4189 (Glean), BAS 9052 (Poast), and Dowco 290 (Lontrel), have been identified through research tests for the control of previously resistant weeds (stinkweed, thistles, hemp-nettle, and volunteer cereals) in field crops. The use of these herbicides will increase yields by reducing competition, and make possible the use of extended rotations with minimum emphasis on summerfallow.

Swathing barley

A 5-yr harvesting study showed that Bonanza barley should be swathed at about 30% kernel moisture content. Swathing at this stage produced the highest yield and quality, eliminated natural shattering, and advanced harvesting by 5–10 days.

PUBLICATIONS

Research

Thorlacius, S. O.; Beacom, S. E. 1981. Feeding value for lambs of fababean, field pea, corn and oat silages. Can. J. Anim. Sci. 61:663-668.

Beacom, S. E. 1981. Practical forage crops systems. Proc. Natl. Forage Crops Symp. (Nov.), Ottawa, Ont.

Miscellaneous

Beacom, S. E. 1981. Acidulated fatty acids improve performance of growing and finishing steers. Canadex 401.50.

Bittman, S.; Waddington, J.; Coulman, B. E.; Bonin, S. G. 1981. Reed canarygrass: A production guide. Agric. Can. Publ. 805. 26 pp.

Research Station
Regina, Saskatchewan

PROFESSIONAL STAFF

J. Dueck, B.S.A., M.Sc., Ph.D.	Director
D. I. Gourlay	Administrative Officer
C. J. Bubar, B.S.A., M.Sc.	Information Officer
H. C. Vanstone[1]	Library Technician

Biological Control of Weeds

P. Harris, B.S.F., D.I.C., Ph.D.	Head of Section; Entomology
M. G. Maw, B.Sc., M.Sc.	Entomology
K. Mortensen, B.Sc., Ph.D.	Plant pathology
D. P. Peschken, B.S.A., M.Sc., Dr.Sci.Agr.	Entomology

Weed Ecology and Physiology

G. I. McIntyre, B.Sc., Ph.D.	Head of Section; Physiology, water relations
G. G. Bowes, B.S.A., M.Sc., Ph.D.	Range weeds
A. I. Hsiao, B.Sc., M.Sc., Ph.D.	Physiology, dormancy
L. Hume, B.Sc., Ph.D.	Crop losses
J. H. Hunter, B.S.A., Ph.D.	Control—annual crops
A. G. Thomas,[2] B.Sc., M.Sc., Ph.D.	Surveys

Environmental Chemistry of Herbicides

R. Grover,[3] B.Sc., M.Sc., Ph.D.	Head of Section; Availability, mobility, monitoring
A. J. Cessna, B.A., Ph.D.	Residues, metabolism, plants
A. E. Smith, B.Sc., Ph.D., F.C.I.C.	Residues, metabolism, soils

Seed Increase

G. R. BOUGHTON, B.S.A., M.Sc.	Head of Section; Increase, distribution and variety verification
E. D. MALLOUGH,[4] B.S.A.	

Experimental Farm, Indian Head, Sask.

W. B. TOWILL, B.S.A.	Superintendent
N. W. HOLT, B.S.A., Ph.D.	Forage and new crops

VISITING SCIENTIST

W. A. QUICK, B.A., B.Ed., M.A., Ph.D.	Weed physiology

[1]Seconded from Libraries Division, Finance and Administration Branch.
[2]On transfer of work program from May 1981.
[3]Acting Director, January to June 1981.
[4]Seconded to a Canadian International Development Agency project in Tanzania.

INTRODUCTION

The Regina Station is a major center for weed research. Programs are designed to cover a broad spectrum of topics on weed biology and control. Control of weeds in commercial crop production continues to rely primarily on the use of herbicides, creating an increasing need for knowledge on efficacy, crop tolerance, persistence in soil and plant tissue, and dissipation in air and surface water, as well as exposure risks to people applying herbicides. Considerations of environmental impact and cost offer encouragement to search for methods to reduce use of herbicides through biological and cultural control and a better understanding of the biology of target species.

In addition to the weed research program, the Station has responsibility for increase and distribution of new crop varieties developed by Agriculture Canada. Cereal, oilseed, forage, and pulse crops are evaluated for adaptability to southeastern Saskatchewan. Agronomic experiments emphasize sustained productivity of the soil.

Inquiries for more detailed information on research activities may be directed to the Research Station, Agriculture Canada, 5000 Wascana Parkway, P.O. Box 440, Regina, Sask. S4P 3A2.

J. Dueck
Director

BIOLOGICAL CONTROL

Leafy spurge

Further work was conducted on several potential agents for biological control of leafy spurge. The root-boring beetles *Oberea erythrocephala* (Schrank.) have survived in small numbers at Caronport, Sask., from a release made in 1979. Others have been released at three additional sites, but breeding success was poor. Low mating frequency may be attributed to a low rate of encounters between the sexes because of the small population released.

Screening tests were completed on a leaf-tying moth, *Lobesia euphorbiana* Frr. Since feeding was restricted to a few species closely related to leafy spurge, the moth appears suitable for use as a biocontrol agent.

A survey for plant pathogens on leafy spurge was conducted in Saskatchewan in 1981. A number of fungi and a bacterial species were isolated but none were found to be sufficiently pathogenic to have potential as biocontrol agents.

Knapweed

In British Columbia, the root-boring beetle *Sphenoptera jugoslavica* Zell. increased on diffuse knapweed to attack half the rosettes within 250 m of release points on both grazed and ungrazed areas. The beetle was distributed to two new sites by transplanting infested roots.

A root and stem rot pathogen, *Sclerotinia sclerotiorum* (Lib.) de Bary, has been reported as a naturally occurring pathogen on diffuse knapweed in various areas of British Columbia and attempts to use it as a biocontrol agent have been initiated. The *Sclerotinia* fungus was cultured on autoclaved wheat kernels and broadcast or incorporated on field plots with heavy infestations of diffuse knapweed at Summerland and Kamloops in the fall of 1981.

A second pathogen native to North America, *Puccinia carthami* Cda. (safflower rust), and two others, *P. jaceae* Otth. and *P. centaureae* D.C. (European knapweed rusts), have shown strong potential as biocontrol agents.

Canada thistle

The stem-gall fly *Urophora cardui* (L.) continued to thrive in Eastern Canada. In New Brunswick, populations from the two release sites situated 4.5 km apart merged and the species increased its range from 1000 ha in 1980 to 2900 ha in 1981. The density of infestation on Canada thistle increased to three galls per plant attacked. Although there was no visible decrease in stand size, affected

plants bearing main-shoot galls showed reductions in plant height of 57% and those with side-shoot galls were reduced 20% in height.

The stem-mining weevil *Ceutorhynchus litura* (F.) was released on the same site as the gall fly in New Brunswick but only became weakly established. Populations of the weevil decreased drastically when fields were cultivated in early spring. Additional agents are required for effective biocontrol of this damaging and vigorous weed.

Sow-thistle

The seed-head fly *Tephritis dilacerata* Loew did not survive the winter in Saskatchewan. In renewed attempts to achieve establishment, an additional 7094 flies were released in Alberta, Saskatchewan, Quebec, and Prince Edward Island.

Approval was obtained for field releases of the leaf-gall fly *Cystiphora sonchi* (Bremi) and almost 31 000 flies were released in Alberta, Saskatchewan, and Quebec. The fly bred at all four sites in Saskatchewan and produced two generations during the summer in at least one site. However, most sow-thistle plants examined had too few galls per rosette to cause reductions in plant vigor.

St. John's-wort

Larvae of the defoliating moth *Anaitis plagiata* (L.) were recovered at Cranbrook, Grandforks, and Agassiz, B.C., for the first time since the release of the moth at these sites in 1967 and 1969. The moth appears to be of value in areas where the beetle *Chrysolina quadrigemina* (Suffr.) has not controlled St. John's-wort. In New Brunswick, the beetle *C. hyperici* (Forst.) filled the niche occupied by *C. quadrigemina* on the west coast. Apparently only one species remains in both areas.

WEED ECOLOGY AND PHYSIOLOGY

Pasture and range weeds

For the 3rd yr, the population and life history of scentless chamomile were studied on one Saskatchewan site. Ninety percent of the plants that overwintered during 1980–1981 survived the 1981 growing season. Seedlings periodically emerged throughout the summer, usually following rain showers.

The total yield of forage on areas sprayed with glyphosate and direct-seeded to alfalfa in 1977 and 1978 increased by 54–57% in 1981. The increase in forage yield was directly related to the successful establishment of alfalfa. Successful direct seeding of legumes into rangeland depended upon the occurrence of above-normal precipitation and the elimination of grazing in the years during and following establishment.

In tests for control of foxtail barley in tall wheatgrass and Russian wild ryegrass, propyzamide at 1.0 kg/ha did not reduce forage yield. The number of seed heads per plant of tall wheatgrass was also similar among plants grown on the treated and untreated plots.

DPX-4189 and surfactant

In field tests, the yield, germination, and seed weight of spring wheat were unaffected by application of DPX-4189 (DuPont) at rates as high as 0.2 kg/ha, suggesting favorable crop tolerance. Treatment of cow cockle with the chemical at rates of 0.02–0.08 kg/ha permitted considerable growth before plants became chlorotic and died. Addition of the surfactant Citowett at 1% vol/vol increased percentage control and the rate of kill by varying amounts, depending on the plant stage at application. In the six-leaf stage, addition of the surfactant resulted in a fourfold increase in control. When applied at the four-leaf stage, an eightfold increase in control resulted because control with DPX-4189 at 0.005 kg/ha plus surfactant was equivalent to the chemical at 0.04 kg/ha without the surfactant.

Seed dormancy in wild oats

Exposure of dormant wild oats (line CS 40) that had imbibed water to either sodium hypochlorite (Javex) or hydrogen peroxide for 1 h, in concentrations normally used for seed sterilization, was sufficient to initiate germination within 48 h. The activity of the enzymes peroxidase and catalase in the treated seeds was greatly reduced immediately after treatment. Signs of recovery of activity were present after 12 h, and by 24 h activity was comparable to that in untreated seeds. As germination progressed, the activity of both enzymes exceeded that in the untreated controls. Levels of amino acids exuding from the treated seeds increased in the initial hours after treatment. It was also during these initial hours that exogenously applied gibberellic acid (GA) had the greatest ability to enter and induce germination in

normally dormant seed lines. GA applied several days after treatment was much less effective. The evidence supports the concept of a membrane repair mechanism that can reestablish the dormant condition.

Dormant seeds of line CS 40 were induced to germinate by piercing the seed coat. It was found that the time required to start germination was directly related to the distance of the puncture from the embryo. Tests further revealed that during the first 3 days of water intake the water content of the embryo (as percentage dry weight) increased rapidly to about 110% and then more slowly to 125% after 10 days. Piercing the seed that had fully imbibed water induced a second phase of rapid water uptake 12–24 h later, followed by germination after approximately 36 h. Isolated embryos from dormant seeds germinated readily within 36 h when supplied only with water. These results suggest that for the strain of wild oats used in this study, dormancy is due primarily to a failure of absorbed water to reach the embryo in the amount required for germination.

Glyphosate translocation in quack grass

In a controlled environment study of factors affecting the translocation of ^{14}C-labeled glyphosate in quack grass, the buds on the rhizome were released from inhibition either by increasing the humidity around the rhizome or by increasing the supply of nitrogen to the parent shoot. Both treatments significantly increased the amount of ^{14}C translocated into the rhizome and caused a two- to threefold increase in the ^{14}C content of the buds. This result emphasizes the importance of bud activity as a factor in the translocation and effectiveness of foliar-applied herbicides.

The role of water in stem elongation

In a series of experiments with dark-grown seedlings of sunflower, it was shown that the stem elongation rate was significantly increased by increasing either the humidity or the potassium supply. Increasing the humidity from approximately 30% to 100% induced immediate growth oscillations that were followed after about 20 min by a 95% increase in the rate of elongation. Application of potassium to the shoot as K citrate, or to the roots as KCl, significantly increased the rate of shoot elongation after approximately 20 and 40 min, respectively, and in both treatments the increased growth was correlated with a reduction in the osmotic potential of the peripheral cell layers. These results support previous evidence that internal competition for water is a major factor in the correlative inhibition of bud growth (stem elongation) in the roots of perennial weeds.

ENVIRONMENTAL CHEMISTRY OF HERBICIDES

Exposure levels during herbicide application

A program was initiated in 1980, in collaboration with the University of Saskatchewan Medical School and Health and Welfare Canada, to obtain reliable and quantitative data on exposure of people to herbicides during application. Exposure of workers in several occupational situations to various herbicides was studied. Analysis of the data on the exposure levels of a work crew making aerial applications of the iso-octyl ester of 2,4-D for brush control established that the major route of entry of the herbicide is dermal (98%) and not through inhalation (about 2%). Ninety percent of the dermal exposure can be eliminated by wearing proper apparel, such as clean cotton coveralls, during spraying. As expected, the person preparing the mixture in the spray tank incurred the highest exposure levels.

Herbicide contamination of irrigation return water

A multi-residue analytical method was developed to determine herbicide residues in water. This method, which permitted a limit of detection of 0.1 $\mu g/kg$, was used in a preliminary study to monitor herbicide contamination of return flow water in order to assess the feasibility of its reuse for irrigation. Individual fields and main drainage canals were examined. Analysis showed that although significant amounts of all herbicides were present in the runoff from individual fields, none of the soil-incorporated herbicides such as triallate, trifluralin, and atrazine were detected in the return flow waters. Bromoxynil, 2,4-D, and diclofop-methyl were detected in both drainage ditches over the period from 11 June to 3 August, the maximum residues being 2.0, 9.4, and 6.1 $\mu g/kg$, respectively.

Herbicide persistence in soils

A 3-yr study on persistence of metribuzin in soil conducted at three locations in Saskatchewan was concluded. For 2 of the 3 yr, metribuzin was recovered from the top 5 cm of the treated plots in amounts varying from 6 to 20% of the original application of 1 kg/ha. Only during 1980 was there any evidence of leaching of metribuzin to soil depths of 5–10 cm.

The persistence of triallate (1.5 kg/ha) and trifluralin (0.75 kg/ha) applied singly and in combination with chloramben (2.0 kg/ha) was compared using small field plots at two locations in Saskatchewan. Applications were made during May 1979, 1980, and 1981 and the plots were sampled and analyzed for triallate and trifluralin remaining after 22 and 52 wk. The results indicate that losses of either chemical were not affected by application in combination with chloramben.

A root bioassay procedure has been developed for the analysis of BAS 9052 (BASF) and DPX-4189 residues in the soil. This technique allows detection of the former herbicide at a rate of less than 0.05 mg/kg in soil, and for the latter at less than 0.0025 mg/kg.

The persistence of ^{14}C-MCPA was studied on three soil types, alone and in the presence of triallate, trifluralin, triallate and trifluralin, malathion, Vitaflow DB (UniRoyal), malathion and Vitaflow DB, bromoxynil, bromoxynil and asulam, bromoxynil and difenzoquat, dicamba, dicamba and mecoprop, linuron, MCPB, metribuzin, propanil, TCA, benzoylprop-ethyl, diclofop-methyl, and flamprop-methyl. None of the chemicals studied adversely affected degradation of MCPA in the soil.

CROP MANAGEMENT

Monoammonium phosphate on wheat

Over the past 37 yr, wheat sown on fallow has been fertilized with monoammonium phosphate (11-48-0) sown with the seed, at incremental rates of 22.4 kg/ha, up to a maximum of 112 kg/ha. The long-term results of this study have shown that yields of unfertilized wheat on fallow have generally declined as a result of decreased availability of fertilizer P in the soil. For the years 1945–1956, the average yield of unfertilized wheat was 2546.8 kg/ha compared with 2217.6 kg/ha for the period 1970–1981. The addition of 11-48-0 at seeding has sustained crop yields, with modest linear increases ranging from 12.7 to 20.5% with increasing rates of fertilizer P.

Phosphate fertilizer and barnyard manure

The practice of incoporating manure at rates of 13.4, 20.1, and 26.0 t/ha in the fallow year of a fallow–wheat–wheat cropping sequence increased 1st-yr grain yields by 5.5, 17.2, and 22.5% in 1981. The effect of barnyard manure in the 2nd yr of cropping was linear, with yield responses averaging 9.5, 24.1, and 30.2%, respectively. Monoammonium phosphate (11-48-0) applied singly at 44.8 kg/ha and in combination with manure at 20.1 t/ha significantly increased wheat yields after fallow by 16.3 and 29.9%, respectively, compared with 13.4 and 33.5% in the 2nd yr of cropping.

Weed control: annual canarygrass, lentils, and triticale

Annual canarygrass was tolerant of several herbicides used for control of wild oats and broad-leaved weeds. However, this crop has only fair tolerance for 2,4-D and DPX-4189 and is not tolerant of diclofop-methyl, metribuzin, or asulam. Propanil did not significantly reduce seed yields at rates double those required for green foxtail control. Adequate crop tolerance and wild oat control were obtained with difenzoquat plus MCPA ester or with MCPA and bromoxynil.

Although metribuzin did not significantly reduce the seed yield of lentils in 1981, the crop showed some phytotoxic effects that were not observed in previous years. This response may be related to above-average rainfall in June and July, which carried the chemical to the rooting zone. Three experimental herbicides provided excellent control of green foxtail in lentils, but when BAS 9052 (BASF) or TF 1169 (Chipman) were combined with metribuzin, crop tolerance was only fair.

Triticale showed excellent tolerance for 16 herbicides for control of either wild oats or broad-leaved weeds. It was also tolerant of the experimental herbicides HOE 654 (Hoechst) and DPX-4189 as well as several combinations of chemicals for control of both wild oats and broad-leaved weeds.

SEED INCREASE AND DISTRIBUTION

In 1981, Agriculture Canada released to SeCan Association 6100 kg of Norbert barley, 3852 kg of Columbus wheat, 654 kg of Leader wheat, 552 kg of Tobin canola/rapeseed, and 525 kg of McGregor flax. Breeder seed of 57 varieties was distributed to 612 growers.

A program for verification of varietal purity of certified seed was again carried out in cooperation with the Food Production and Inspection Branch and the Canadian Seed Growers' Association. The general level of contamination in 2396 samples was low except in Elrose barley, Glenlea wheat, and Dufferin flax. These three varieties contained off-types that originated in breeder seed.

PUBLICATIONS

Research

Bowes, G. G. 1981. Control of aspen regrowth in Western Canada when there is an understory of established alfalfa. J. Range Manage. 34:412-415.

Cessna, A. J. 1981. Determination of triallate residues in alfalfa and companion crops of wheat and barley. Can. J. Plant Sci. 61:765-768.

Grover, R.; Bowes, G. G. 1981. Picloram residue levels for the control of leafy spurge regrowth. Can. J. Plant Sci. 61:661-664.

Grover, R.; Kerr, L. A.; Khan, S. U. 1981. Multidetector gas chromatographic determination and confirmation of airborne triallate residues in Saskatchewan. J. Agric. Food Chem. 29:1082-1084.

Hayden, B. J.; Smith, A. E. 1980. Comparison of the persistence of ethalfluralin and trifluralin in Saskatchewan soils. Bull. Environ. Contam. Toxicol. 25:508-511.

Holt, N. W.; Sosulski, F. W. 1981. Nonprotein nitrogen contents of some grain legumes. Can. J. Plant Sci. 61:515-523.

Hsiao, A. I.; Hanes, J. A. 1981. Application of the sodium hypochlorite seed viability test to wild oat populations with different dormancy characteristics. Can. J. Plant Sci. 61:115-122.

Hsiao, A. I.; Worsham, A. D.; Moreland, D. E. 1981. A bioassay for *dl*-strigol using witchweed [*Striga asiatica* (L.) Kuntzel] seed germination. Pflanzenphysiol. 104:1-8.

Hsiao, A. I.; Worsham, A. D.; Moreland, D. E. 1981. Effects of sodium hypochlorite and certain plant growth regulators on germination of witchweed (*Striga asiatica*) seeds. Weed Sci. 29:98-100.

Hsiao, A. I.; Worsham, A. D.; Moreland, D. E. 1981. Regulation of witchweed (*Striga asiatica*) conditioning and germination by *dl*-strigol. Weed Sci. 29:101-104.

Maw, M. G.; Schroeder, D. 1981. *Euzophora cinerocella* (Zeller) (Lep: Pyralidae) not suitable for release to control *Artemisia absinthium* L. (Compositae) in Canada. Z. Angew. Entomol. 92:178-184.

McIntyre, G. I. 1981. Apical dominance in the rhizome of *Agropyron repens*: The influence of humidity and light on the regenerative growth of isolated rhizomes. Can. J. Bot. 59:549-555.

Peschken, D. P.; Wilkinson, A. T. S. 1981. Biocontrol of Canada thistle (*Cirsium arvense*): Releases and effectiveness of *Ceutorhynchus litura* (Coleoptera: Curculionidae) in Canada. Can. Entomol. 113:777-785.

Smith, A. E. 1981. Comparison of solvent systems for the extraction of atrazine, benzoylprop, flamprop and trifluralin from weathered field soils. J. Agric. Food Chem. 29:111-115.

Smith, A. E. 1981. Persistence studies with (^{14}C) 2,4-D in soils previously treated with herbicides and pesticides. Weed Res. 20:355-359.

Miscellaneous

Shewchuk, S. R.; Grover, R. 1981. Design, construction and field testing of a portable micrometeorological system to study pesticide volatilization and vapour transport. Sask. Res. Counc. Publ. No. P-780-2-E-81. 27 pp. + appendix.

Smith, A. E. 1981. Measuring field persistence of herbicides using micro-plots. Can. Agric. 26:17-18.

Smith, A. E.; Secoy, D. M. 1981. Plants used for agricultural pest control in western Europe before 1850. Chem. Ind. 12-17.

Research Station
Saskatoon, Saskatchewan

PROFESSIONAL STAFF

J. R. Hay, B.S.A., M.S., Ph.D., F.W.S.S.A.	Director
R. K. Downey, O.C., B.S.A., M.Sc., Ph.D., F.A.I.C., F.R.S.C.	Assistant Director; Oilseed breeding—rapeseed
R. J. Peters	Administrative Officer
M. A. Glen,[1] B.A., M.L.S.	Librarian
C. E. Lynn, B.S.A.	Information Officer
M. J. Bentham, B.Sc.	Computer Systems Manager
H. K. Milne	Computer Systems Programmer
D. T. Spurr, B.Sc., M.Sc., Ph.D.	Statistician

Crop Management and Project Farms

K. J. Kirkland, B.S.A., M.Sc.	Head of Section; Weeds and crop management
S. A. Brandt, B.S.A., M.Sc.	Agronomy

Plant Breeding and Agronomy

B. P. Goplen, B.S.A., M.Sc., Ph.D.	Head of Section; Legume breeding
W. L. Crowle, B.S.A., M.Sc.	Cereals and crop management
R. E. Howarth, B.S.A., M.Sc., Ph.D.	Legume bloat—biochemistry
A. J. Klassen, B.S.A., M.Sc., Ph.D.	Oilseed breeding—rapeseed
R. P. Knowles, B.S.A., M.Sc., Ph.D., F.A.I.C.	Grass breeding
G. L. Lees, B.Sc., Ph.D.	Legume bloat—plant physiology
D. I. McGregor, B.Sc., M.Sc., Ph.D.	Physiology of *Brassica* spp.
G. F. W. Rakow, B.S.A., Ph.D.	Oilseed breeding—rapeseed
G. Séguin-Swartz, B.Sc., Ph.D.	Cytogenetics of *Brassica* spp.
L. G. Sonmor, B.S.A., M.Sc.	Irrigation
H. Ukrainetz, B.S.A.	Soil fertility
D. L. Woods, B.Pharm., M.Phil., Ph.D.	Oilseed breeding—mustard, sunflowers

Entomology

R. H. Burrage, B.S.A., Ph.D., F.E.S.C.	Head of Section; Wireworms
L. Burgess, B.Sc., M.Sc., Ph.D.	Associate Head; Oilseed crop insects
A. P. Arthur, B.Sc., M.S., Ph.D.	Oilseed crop insects
C. H. Craig, B.A.	Forage crop insects
G. R. F. Davis, B.Sc., M.Sc., Ph.D.	Insects—physiology and nutrition
J. F. Doane,[2] B.S.A., M.S., Ph.D.	Insects—ecology and behavior
A. B. Ewen, B.A., M.A., Ph.D., F.R.E.S.	Insects—ecology and pathology
R. J. Ford, B.S.A., M.Sc., Ph.D.	Engineering
F. J. H. Fredeen, B.S.A., M.Sc.	Black flies
L. B. Hayles,[3] D.V.M. & S., Ph.D., M.R.C.V.S.	Mosquitoes and arboviruses
K. S. McKinlay, B.Sc., M.Sc., Ph.D.	Insects—toxicology
M. K. Mukerji, B.Sc., M.Sc., Ph.D.	Insects—management
O. O. Olfert, B.Sc., B.S.A., M.Sc., Ph.D.	Insects—ecology
N. D. Westcott, B.Sc., Ph.D.	Pesticides—chemistry

Plant Pathology

R. D. Tinline, B.A., M.Sc., Ph.D.	Head of Section; Cereal root diseases
L. J. Duczek, B.S.A., M.Sc., Ph.D.	Cereal root diseases
H. Harding, B.Sc., Ph.D.	Cereal root diseases
G. A. Petrie, B.A., M.A., Ph.D.	Oilseed crop diseases
J. D. Smith,[4] B.Sc., M.Sc.	Forage and low-temperature diseases
P. R. Verma, B.Sc., M.Sc., Ph.D.	Cereal root diseases

Departures

J. Dueck, B.S.A., M.Sc., Ph.D. Appointed Director, Regina Research Station, July 1981	Oilseed crop diseases
Y. W. Lee, B.S., M.S., Ph.D. Retired August 1981	Pesticide chemistry

VISITING SCIENTISTS

S. N. Acharya, M.Sc., Ph.D. Canola Council of Canada visiting fellow, 1980–1982	Plant pathology
E. Acikgoz, B.Sc., Ph.D. National Research Council of Canada visiting fellow, 1980–1981	Plant breeding

Graduate students

E. J. DALRYMPLE, B.Sc. (Agr.)	Plant breeding
D. DOSTALER, B.Sc., M.Sc.	Plant pathology
D. S. HUTCHESON, B.A., B.S.A.	Plant breeding
C. L. VERA, Ing. Agron., M.Sc.	Plant breeding

[1]Seconded from Libraries Division, Finance and Administration Branch.
[2]On transfer of work to Owairaka Research Centre, Auckland, New Zealand, 12 August 1981 to 12 August 1982.
[3]On leave, FAO assignment to Somalia, East Africa, from 1 October 1979 to 23 October 1981.
[4]On a Canadian International Development Agency (CIDA) assignment to Njoro, Kenya, from 1 November 1981 to 31 October 1982.

INTRODUCTION

This report covers the major research achievements in 1981 at the Saskatoon Research Station and the Scott Experimental Farm.

Four research programs are conducted. The oilseed, forage crops, and cereal programs include research on breeding, agronomy, and control of diseases, weeds, and insects. We have the major responsibility in the Research Branch for research on rapeseed/canola and mustard. We, along with the Lethbridge and Kamloops stations, are an integral part of the Branch's research program on development of bloat-safe alfalfa. We have a major responsibility for the development of forage grasses for the northern prairies. The cereal program is mainly concerned with reducing losses from root rot in wheat and barley, and with the breeding of utility wheats. The integrated pest management program deals with the development of control systems for problem insects (i.e. grasshoppers, wireworms, mosquitoes, black flies) that are not specifically restricted to any one commodity. A major objective in the program is the minimization of our dependence on insecticides for the control of these pests.

During 1981, Dr. R. K. Downey, who very capably served as Acting Director in 1979 and 1980, chose to return to his research and is now program leader for the oilseed research. Dr. J. Dueck, plant pathologist for oilseeds, was transferred to Regina where he became the Director of the Station. Dr. Y. W. Lee, pesticide chemist, retired. Our librarian, E. J. Watson, resigned during the year and was replaced by M. A. Glen. Mr. R. J. Peters became the Administrative Officer. Two scientists joined the oilseed program, Dr. G. Séguin-Swartz as a cytogeneticist and Dr. G. Rakow as a plant breeder.

Two members took leave to work on foreign assignments for CIDA: J. D. Smith to Njoro, Kenya, to work on plant diseases, and M. S. Bahrey to Zambia to work on a cereal breeding program.

Previous reports and reprints of publications can be obtained from the Saskatoon Research Station, Research Branch, Agriculture Canada, 107 Science Crescent, Saskatoon, Sask. S7N 0X2.

J. R. Hay
Director

OILSEEDS

Rapeseed/canola

Breeding. The low-erucic-acid, low-glucosinolate *Brassica campestris* L. strain DH-716 was licensed under the cultivar name Tobin and released to seed growers through SeCan Association in 1981. Tobin is the first Canadian cultivar of this species that has a high level of resistance to white rust, *Albugo candida* (Pers. ex Lév.) Ktze. Normally, the disease has caused a yield loss of 2–9% a year in this species. The source of the resistance was *B. campestris* introductions from Central and South America.

Tolerance for triazine herbicides has been incorporated into canola strains with resistance to white rust and blackleg diseases. Evaluation of the agronomic performance of these lines will begin in 1982. If successful, these new strains will allow control of stinkweed and wild mustard in canola.

B. napus selections with 8–10% higher levels of linoleic acid and 2–3% lower levels of linolenic acid than Regent and Andor have been identified. These C_{18} fatty acid modifications will improve both the nutritional properties and stability of canola oil.

Mucilage-free *B. campestris* canola selections were developed and are being multiplied for pilot-scale processing to determine the effects of mucilage on processing characteristics and losses. The presence of mucilage was found to be controlled by two genes exhibiting dominance epistasis. There was no discernible correlation between seed-coat color and the presence of mucilage.

Insects. In cooperation with seven agricultural representatives from the Saskatchewan Department of Agriculture, 45 bertha armyworm pheromone traps were located through northeastern Saskatchewan. Moth catches of 20 or more a week were recorded between 28

June and 26 July at Aylsham, Zenon Park, Love, Arborfield, Prairie River, Melfort, Bjorkdale, Leroy, Kinistino, Prince Albert, Tisdale, Porcupine Plain, White Fox, and Carrot River. Larval surveys indicated high infestations in several rape fields near Zenon Park, with maximum populations of 260/m^2. Insecticide treatments were required in this area. Larval infestations in the other locations were spotty. Natural mortality of larvae collected in the Zenon Park area was due to *Banchus flavescens* Cress., 7–37%; dipterous spp., 1–18%; and disease organisms, 12–47%.

Diseases. In June 1981, the virulent strain of blackleg, *Leptosphaeria maculans* (Desm.) Ces. & de Not., was unusually widespread on the developing crop. In many instances, plants had been infected as seedlings. Infection was traced to ascospores from 2- or 3-yr-old rapeseed trash which, because of unusually dry conditions, had not decayed at the normal rate.

The effect of soil moisture on ascospore production by *L. maculans* on buried, naturally infected rapeseed stems was examined under controlled conditions. Release of ascospores declined sharply and irreversibly within 10 days following burial in soils that had moisture levels higher than 40% of field capacity (FC). Stems kept in dry soil (13% FC) continued to release large numbers of spores. Thus, burial of rapeseed crop residue in moist or wet soil is an effective means of lowering the sporulation potential of the pathogen.

The blackleg fungus has been induced to form the sexual state in culture in the laboratory. This result had not been accomplished previously using strains of the pathogen indigenous to Canada and will enable a study of the genetic control of virulence.

Considerable progress was made toward the development of a blackleg-resistant cultivar of *B. napus*. Several breeding lines were tested in the blackleg field nursery and others were artificially inoculated in growth chambers. In both instances, several crosses involving tolerance material had more tolerance than Regent.

The severity and geographical distribution of stem rot of rapeseed caused by *Sclerotinia sclerotiorum* (Lib.) de Bary in Western Canada was estimated from the numbers of sclerotia found in samples drawn by the Canadian Grain Commission from every carload of rapeseed received at Vancouver terminals from 1973 to 1981. The data indicate that the incidence and severity of the disease in Alberta crop districts 4, 5, and 6, which surround Edmonton, have been high in almost every year examined. The incidence has also been high in the Peace River region of Alberta. In Manitoba, severity has been moderate. In Saskatchewan, the disease was common and widespread in northern crop districts 8 and 9, but severity was low in most years surveyed. The disease appears to be of minor importance in the southern parts of the rapeseed-growing areas of Alberta and Saskatchewan.

The use of benomyl for the control of *Sclerotinia* in Canada, developed at this Station and described in the 1980 report, was used in commercial field experiments by the Alberta Department of Agriculture in 1981. Economic yield increases were obtained in nearly every *B. napus* field where the applications were made. It is expected that fungicidal control of this disease will become a common commercial practice in areas where the disease is widespread and severe.

Germination in cold seedbeds. Rapeseed cultivars with good germinability and strong seedling vigor under adverse conditions are essential for high yields. Cool spring soil temperatures appear to be a major factor affecting establishment of canola stands in Western Canada. Slow germination and seedling establishment in cold seedbeds have a double detrimental effect. First, slow germination reduces the yield potential by shortening the growing season, and second, the slower growth makes the seedlings more vulnerable to soil-borne pathogenic invasion.

Results of studies to select genotypes that are cold tolerant indicate that the canola genotypes now grown in the Canadian prairies have a narrow range of variability for seedling vigor at cold temperatures. Heritability estimates for rapid germination at cold temperatures were low. Selections within commercially grown genotypes for rapid germination showed that advances within currently grown varieties are possible. However, to obtain the desired germinability and vigor, additional variability would need to be drawn from the world resources of germ plasm.

The most important seedling disease of cultivated canola was found to be *Rhizoctonia solani* Kühn or foot rot of rapeseed. Unfortunately, none of the genotypes tested had complete immunity to this pathogen either at

RESEARCH STATION, SASKATOON, SASK.

the pre- or post-emergence stage. However, using a newly developed inoculation technique, genotypes with an increased degree of tolerance have been identified and will be field-evaluated in 1982.

Agronomy. Sulfur deficiency for canola production in northern Saskatchewan is a problem that occurs mainly on Dark Gray and Gray Luvisolic soils. Studies with rapeseed/canola on S-deficient Loon River loam (Gray Luvisolic) have shown that large yield increases can be obtained when soluble-sulfate forms of S are applied with adequate N. However, elemental forms of S have given little or no yield increase when applied at or just before seeding of rapeseed/canola.

A field plot study was carried out during 1980–1981 to determine the rate of oxidation of several elemental S fertilizers on a Loon River loam soil under natural climatic conditions at Loon Lake, Sask. Three elemental S fertilizers, namely Agrisul, Prilled Sulfur, and Flowable-sulfur (a finely divided elemental S in liquid suspension), as well as ammonium sulfate and gypsum, were studied.

There was very little oxidation of Agrisul or Prilled Sulfur in plots during the 2-yr period. Oxidation of the Flowable-sulfur was considerably greater than for the other two elemental forms. Studies are being carried out to determine if the slow rate of oxidation of these elemental S fertilizers is due to a low population of S-oxidizing organisms in the soil.

The response of canola to applied S on S-deficient Loon River soil during 1980 and 1981 was closely related to the S oxidation study results on this soil. Agrisul and Prilled Sulfur gave rise to little or no yield increase; Flowable-sulfur application gave somewhat larger yield increases, and relatively large yield increases were obtained with use of soluble sulfate sources such as ammonium sulfate and sodium sulfate.

Weed control. Stinkweed has become a problem associated with production of rapeseed. In rotations with rapeseed, the density of stinkweed plants was 15 times higher than in rotations without rapeseed. When rapeseed was grown every 2 or 3 yr, the population of stinkweed was twice as high as when it was included only once in 4 or 6 yr.

One of the major weed problems in stubble-seeded rapeseed is volunteer wheat and barley. BASF-9052 (BASF) at 0.2 and 0.4 kg/ha in combination with Atplus surfactant at 0.5% reduced volunteer wheat stands in rapeseed by 67 and 100%, respectively, and volunteer barley stands were reduced 58 and 100% at the same rates. Canola yield increases ranged from 70 to 150%.

Physiology. Environment has a significant effect on glucosinolate levels in the seed. Three cultivars of canola (Altex, Candle, and Regent) were grown from 1976 through 1980 at Beaverlodge and Ellerslie, Alta.; Saskatoon, Sask.; and Morden, Man. Overall coefficient of variability for location and year of the glucosinolates that give rise to isothiocyanates and oxazolidinethiones was 21.8, 26.4, and 25.8 for Altex, Candle, and Regent. For 3-methylindolyl and 1-methoxy-3-methylindolyl, the indole glucosinolates, the coefficients of variability were much lower: 12.5, 14.7, and 17.5 for Altex, Candle, and Regent. Even when the coefficient of variability of 5.0 for the analytical method is taken into account, the results indicate that the glucosinolate content in seed of pure breeding cultivars can vary widely, depending on the environment under which the seed is formed.

Volunteer growth of rapeseed and mustard early in the spring had a detrimental effect on subsequently seeded crops. When rapeseed and mustard seedlings with up to two leaves were incorporated into the seedbed prior to seeding cereal and oilseed crops, germination and seedling vigor were reduced. Stands were reduced 25–80%, and seed yields were 30–60% lower than where no vegetation was incorporated prior to seeding.

The stands and yields of flax and rapeseed were more severely affected than those of barley, oats, and wheat. The adverse effects on the subsequently seeded crops increased as the amount of spring-incorporated vegetation was increased. Incorporation of straw or green seedlings and plants, or both, in the fall had no adverse effect on spring-sown crops. Thus, to eliminate or minimize detrimental effects of rapeseed or mustard on subsequently sown crops, seed losses at harvest should be minimized and agronomic practices followed that will favor fall germination of any seed left in the field.

Mustard

Yeast-infected seed. In 1979, for the first time, a heavy and widespread infestation of the yeast *Nematospora coryli* Peglion occurred in seed from commercial mustard fields throughout the Prairie Provinces. The yeast

did not appear to affect seed yields adversely but it did increase the cost of processing mustard flour. Examination of seed samples retained from 1977 and 1978 showed a very low incidence in those years. Seed samples provided by seed-contracting companies have shown that the initial 1979 infection was concentrated in the northern Montana–Alberta–Saskatchewan border areas. In 1980 the incidence was lower, with the heaviest concentration centered in southern Saskatchewan. The 1981 infestation was relatively low, with the heaviest concentration occurring in North Dakota.

When the source and mode of infection were investigated it was found that the yeast was concentrated inside a small percentage of seeds and that these seeds were smaller and usually misshapen. Unfortunately, size and shape of the infected seeds were not sufficiently different from the norm to permit physical removal of the shrunken seeds from commercial seed. The incidence and type of infection suggested that an insect vector was involved. A literature search indicated that *N. coryli* is a pathogen of a number of plants, but there seem to be no previous records of this yeast infecting cruciferous plants. The organism is known to be transmitted by some piercing and sucking insects.

Investigations in Saskatchewan in 1981 identified 15 piercing and sucking insects that will feed on the green pods of *B. juncea*. Three of these, the false chinch bug, the western damsel bug, and plant bugs of the genus *Lygus*, were found to carry *N. coryli* internally, and in laboratory experiments the false chinch bug was able to transmit this organism to healthy mustard plants. Transmission experiments with the western damsel bug and *Lygus* bugs were inconclusive.

In the main *B. juncea* study field, located in southeastern Saskatchewan, the pods of mustard plants in a small area heavily infested with the false cinch bug proved to be heavily infected with *N. coryli*. Elsewhere in the field few false chinch bugs and no infected plants were found. These observations, together with the demonstrated transmission capability of the false chinch bug, suggest that this insect may be a vector of *N. coryli* in western mustard crops. Investigations of the transmission role of the false chinch bug and other insects are continuing.

RESEARCH STATION, SASKATOON, SASK.

Sunflower

Insects. In 1981, wild sunflower heads were collected on 16 and 17 July and 19 or 20 August at each of the following Saskatchewan locations: Saskatoon, Outlook, Eyebrow, and Briercrest. Collections at Saskatoon and Outlook were from *Helianthus petiolaris* Nutt., those at Briercrest from *H. annuus* L., and those at Eyebrow from both species. The sunflower moth, *Homoeosoma electellum* (Hulst), the sunflower seed maggot, *Neotephritis finalis* (Loew.), and sunflower seed weevil, *Smicronyx fulvus* Lec., occurred in collections from all four locations. Banded sunflower moths, *Cochylis* spp., and a stem weevil, *Apion* sp., occurred in collections from Eyebrow, Outlook, and Briercrest but not Saskatoon. Large numbers of banded sunflower moth larvae were found in the wild sunflower heads collected at Eyebrow when they were examined in October. This is consistent with the observation that these larvae are sometimes found in roasted confectionary sunflower seeds. This is the 1st yr that the dried heads were dissected; thus this species is probably more abundant in Saskatchewan than our previous records would indicate.

CEREALS

Wheat and barley

Diseases. The loss from common root rot, *Cochliobolus sativus* (Ito & Kurib.) Drechsl. ex Dastur, in common wheat in 1981 in Saskatchewan was 6.9% compared with 6.6% in 1980. The severity ratings were 22% in 1981 and 1980.

The development of common-root-rot-resistant lines of wheat having agronomic attributes acceptable for use as breeding parents is proceeding. The average disease severity rating of 20 promising lines was 8%, compared with 16% for Neepawa, and the lines outyielded Neepawa by an average of 13%.

In zero-tillage tests at Scott, wheat was less severely damaged by common root rot when seeded directly into stubble than when seeded after preseeding tillage operations. In similar tests at Melfort, there was no difference. In other tests at Melfort, disease ratings were higher when seeding was done by a discer than when done with seed drills.

Incidence and intensity of common root rot in wheat were not markedly affected by rate of seeding or density of stand. This finding suggests that interplant spread of the disease is insignificant and that the cultivar reaction is not modified by interplant competition. This is pertinent in the selection of lines for resistance, because their disease ratings may be based on plants seeded at different densities.

Extensive numerical analyses of morphological, physiological, and pathogenicity data on 250 randomly selected isolates of *C. sativus* indicate that three discrete groupings may be recognized. There is some indication that the prevalence of these groups varies with geographic area. Conidium morphology, colony morphology on selected media, lesion type on detached wheat leaves, and rate of lesion development on subcrown internodes seem to be most useful in distinguishing "ecological strains."

More than 1400 lines of barley from the U.S. Department of Agriculture World Collection and from Canadian plant breeders were evaluated for common root rot reaction, and a few promising resistant lines were saved.

A 3-yr study at two locations on the effect of depth and date of seeding on common root rot of barley showed that the disease was not influenced by seeding date, but root rot severity increased with deeper seeding. Grain yields decreased with deeper and with later seeding.

Conidia of *C. sativus* can be recovered from soil using an oil–water flotation technique. The number of spores can be estimated by counting all spores with gross morphology similar to that of the spores of *C. sativus*. Single-conidium isolations were made to verify this procedure, based on characteristics in culture, on the ability to produce spot blotch on barley, and on conidial length. The procedure was 99% accurate for soils collected in Saskatchewan. The 1% error was because of confusion with conidia of *Curvularia spicata* (Bainier) Boedijn.

Of 22 seed treatments tested for the control of common root rot in Galt barley, three chemicals, nuarimol, etaconazole, and triadimenol, significantly reduced the symptoms of root rot. In one nuarimol treatment there was a corresponding 25% yield increase.

In a survey of Saskatchewan soils, low numbers of spore-perforating amoebas were present in all areas of the province. Differences in numbers occurred among crop districts, soil zones, and soil textures. The role of these organisms in the survival of conidia of *C. sativus* or the usefulness of amoebas as biological control agents has yet to be determined.

In growth chamber experiments, data on temporal progression of common root rot lesions on individual subcrown internodes of three wheat cultivars (Cypress, Neepawa, and 680-1) and two barley cultivars (Galt and Bonanza) were in good agreement with end-of-season disease reaction data from the field. Disease progressed faster in barley than in wheat. Comparisons were based on the following variables: mean number of days required to attain maximum possible vertical lesion length; mean daily rates of linear development; percentage disease ratings; and probabilities of plants becoming infected, and also of infected plants being transferred from less to more severe disease categories. They showed that among the three wheats, Cypress was the most susceptible and 680-1 was the least. In barley, Galt was more susceptible than Bonanza. Growth chamber experiments determining effect of age of plants on infection and temporal development of root rot in wheat and barley showed that rates of both vertical and lateral progression of subcrown internode lesions were faster in older than in younger plants.

Effect of seed treatment fungicides on sporulation of *C. sativus* on basal stems, crowns, and subcrown internodes of wheat was studied in separate field trials in 1980 and 1981. Results showed that plants grown from seeds treated with baytan, imazalil, and nuarimol at a.i. rates of 0.3, 0.2, and 0.15 g/kg seed, respectively, invariably had significantly lower sporulation indices than those in the untreated control. Among the three fungicides, nuarimol resulted in the lowest sporulation, followed by imazalil and baytan.

Results of greenhouse studies in soil infested with different concentrations of *C. sativus* conidia (ranging from 0 to 2560 conidia per gram of soil) showed that about 85% of the disease intensity in Cypress and Neepawa wheat could be achieved with only 80 conidia per gram of soil. Concentrations higher than this did not increase the percentage disease ratings.

Agronomy. A crop rotation study was initiated at Scott in 1966 on a Dark Brown

clay loam soil. Emphasis was placed on determining the effects of rotation on soil moisture levels. Of the grain crops grown, wheat made the most complete use of soil moisture. There was less than 40 mm of available moisture in the soil after harvest of wheat seeded on stubble or on summerfallow. After *B. campestris* rapeseed, there was 60 mm of available moisture. Oats were intermediate between wheat and rapeseed. Crops grown on rapeseed stubble would benefit from this additional moisture. In a summerfallow–rapeseed rotation, surplus soil moisture seepage could occur and cause salinity problems.

Vigorous, well-established alfalfa plants are difficult to eradicate when plowed down, and continue to use moisture during the fallow period. When alfalfa was plowed down in the year following establishment, some soil moisture recovery occurred in the late summer, and soil moisture storage in the succeeding fallow year was only slightly lower than for the grain crop rotations. However, when alfalfa was grown for an additional year, little moisture storage occurred in the late summer after plow-down or during the following summer during the fallow period. Thus, less moisture was available to the next crop grown on fallow and yields were adversely affected.

Weed control. The six-row barley cultivars Melvin, Johnston, and Klondike were tolerant of diclofop-methyl, HOE 00654 (Hoechst), difenzoquat, TCA, propanil plus MCPA, cyanazine plus MCPA, and 3,6-dichloropicolinic acid (Dow). Slight damage was visible when dicamba was applied alone but it increased markedly when dicamba was tank-mixed with metribuzin or TCA. The two-row cultivars Elrose and Harrington were tolerant of difenzoquat, propanil plus MCPA, TCA, cyanazine plus MCPA, and dicamba. A maturity delay of 1 or 2 days resulted from the application of diclofop-methyl, and 3 or 4 days from HOE 00654.

Large areas of cereals in northwestern Saskatchewan are infested with corn spurry and narrow-leaved hawk's-beard, which are resistant to 2,4-D and MCPA. Metribuzin alone or in combination with MCPA, DPX-4189 (DuPont), and cyanazine plus MCPA provided total control of corn spurry if applied when the weeds were less than 10 cm tall. Fall applications of metribuzin, DPX-4189, and 3,6-dichloropicolinic acid on stubble reduced stands of overwintering narrow-leaved hawk's-beard by 98, 100, and 100%. Fall application of 3,6-dichloropicolinic acid also provided good control of the narrow-leaved hawk's-beard that germinated in the spring.

FORAGES

Legumes

Legume pasture bloat research. The major goal in this program is to develop bloat-safe alfalfa cultivars. A nylon bag technique is used to select alfalfa plants with cells that resist breakdown. Plants in the second cycle of recurrent selection were established in the field in 1981 and will be screened and selected for a third cycle of selection in the summer of 1982. Following the third cycle of selection, the proposed bloat-safe synthetic will be evaluated in pasture trials at Kamloops using fistulated cattle to verify reduced bloat potential.

There is an association between the frequency of bloat in cattle and the concentration of chloroplast particles in rumen fluid. Because the disappearance of these particles from the rumen is relatively slow, they may predispose the ruminal contents to bloat. Although the concentrations of soluble protein in rumen fluid were adequate to cause foaminess, high levels of soluble proteins do not appear to be responsible for daily changes in the occurrence of legume bloat.

The leaf morphology of six forage legumes was related to their bloating potential. The most striking example is the bloat-safe species cicer milkvetch. Unlike legume species with parallel veins, cicer milkvetch has a reticulate venation with firm attachments to the upper and lower epidermal layers. This undoubtedly restricts the invasion of rumen bacteria and presumably slows the rate of leaf digestion.

Leaves of the bloat-safe species sainfoin and bird's-foot trefoil contained condensed tannins in sacs extending from the upper epidermis or distributed in the mesophyll tissue. The presence of tannin, a known enzyme inhibitor, greatly reduced the rate of digestion. Leaves from the bloating species alfalfa, red clover, and white clover do not have tannin sacs in the leaves and were all digested at a faster rate.

In a genetic study, the inheritance of tannins in bird's-foot trefoil was found to be controlled by a single dominant gene.

Research is continuing in our laboratory to investigate the feasibility of using leaf morphology as a selection tool in breeding a bloat-safe alfalfa.

INTEGRATED PEST MANAGEMENT

Black flies

Long-term effects of black fly larva control with methoxychlor. In attempts to prevent widespread outbreaks of *Simulium arcticum* N. & M. in east-central Saskatchewan, methoxychlor was injected into the Saskatchewan River once in 1976, six times in 1977, seven in 1978, nineteen in 1979, and five times in 1980. Outbreaks of *S. luggeri* remained widespread and severe until 1979, when residents in some 100 000–300 000 ha experienced relief for the first time in several years.

Unexpectedly, numbers of most nontarget invertebrates in the Saskatchewan River increased during this period of intensive use of methoxychlor. Trends were similar whether measured in mid-river sites or along river margins.

Qualitatively, also, the fauna appeared to be healthy at the conclusion of tests. Detailed analyses of the 1980 samples proved the existence of a richly varied fauna, representing wide ranges of activity patterns, feeding habits, biomass, and life cycles.

These results support data from less detailed studies in 1973 which showed relatively rapid repopulation of a 160-km section of the North Saskatchewan River following a single injection of methoxychlor. It is hoped that regulatory agencies will use these data when studying requests for permits for use of methoxychlor as a larvicide.

Grasshoppers

Control. A comprehensive grasshopper management system for prairie agriculture involves gathering information about the grasshopper–host crop ecosystem, using this information as a basis for decision making, and exercising optimum control strategy. A conceptual model was developed which provides a framework for quantitative analysis of the biological and economic relationships underlying crop protection from grasshoppers.

This conceptual model should indicate optimum control strategies based on the economic threshold of the population, given the status of the crop and the efficacy of recommended control methods. The model will incorporate control practices such as poison bait and cultural and biological methods that will reduce the amount of insecticide required.

Bran baits. Grasshoppers are attracted to bran. In tests on application of insecticides on bran baits, three of these, dimethoate, pyridaphenthion (Chipman Chemical Ltd.), and propoxur, were nearly 30 times more effective as baits than as sprays. By contrast, the other four compounds, Pay-off (American Cyanamid), deltamethrin, FCS-303 (Velsicol Chemical Corp.), and Bay FCR 1272 (Bayer AG), were only two to five times more effective on baits.

Insect nutrition

Mycotoxins. A strain of *Fusarium sporotrichioides* Sherbakoff, obtained on hay from Kindersley, Sask., has been demonstrated to be capable of producing T-2 toxin under laboratory conditions. Studies with pure T-2 toxin included in the diet of larvae of *Tenebrio molitor* L. showed that larval growth, but not survival, was influenced by dietary protein and T-2 toxin concentrations. T-2 toxin reduced food and protein utilization by the larvae and, consequently, gain in larval weight. In this study, efficiency of feed conversion was constant, but efficiency of protein conversion was influenced both by dietary protein and by dietary T-2 toxin levels. Concentrations of T-2 toxin of 64 and 128 mg/kg depressed larval growth, but these levels far exceed biologically active levels in vertebrates.

Methods. A technique has been developed, using larvae of *T. molitor*, which provides an excellent means of estimating food and protein utilization and conversion for insects living and developing in their dietary substrate. This method obviates the need for separating feces from food and the need for monitoring uric acid production by the insects, such as is necessary with other techniques.

PUBLICATIONS

Research

Anand, I. J.; Downey, R. K. 1981. A study of erucic acid and alleles in digenomic rapeseed (*Brassica napus* L.). Can. J. Plant Sci. 61:199-203.

Arthur, A. P. 1981. Host acceptance by parasitoids. Pages 97-120 *in* Nordlund, D. A.; Jones, R. L.; Lewis, W. J., eds. Semiochemicals: their role in pest control. John Wiley & Sons, Inc., New York.

Arthur, A. P.; Bauer, D. J. 1981. Evidence of the northerly dispersal of the sunflower moth by warm winds. Environ. Entomol. 10:528-533.

Bell, J. M.; Shires, A.; Blake, J. A.; Campbell, S.; McGregor, D. I. 1981. Effect of alkali treatment and amino acid supplement on the nutritive value of yellow and Oriental mustard meal for swine. Can. J. Anim. Sci. 61:783-792.

Burgess, L. 1981. Winter sampling to determine overwintering sites and estimate density of adult flea beetle pests of rape (Coleoptera: Chrysomelidae). Can. Entomol. 113:441-447.

Campbell, C. A.; Nicholaichuk, W.; Biederbeck, V. O.; Ukrainetz, H.; Bole, J. 1981. An empirical method of estimating soil temperature on cropped land on Canadian prairies. Can. J. Plant Sci. 61:565-573.

Coxworth, E.; Kernan, J.; Knipfel, J.; Thorlacius, O.; Crowle, L. 1981. Review: Crop residues and forages in Western Canada; potential for feed use either with or without chemical or physical processing. Agric. Environ. 6:245-256.

Davis, G. R. F.; Schiefer, H. B. 1981. Growth of the yellow mealworm fed graded doses of mycotoxins at three dietary protein levels. Nutr. Rep. Int. 23:1105-1111.

Davis, G. R. F.; Smith, J. D. 1981. Effect of light and incubation temperature on production by species of *Fusarium* of metabolites toxic to larvae of *Tenebrio molitor* (L.). Arch. Int. Physiol. Biochim. 89:81-84.

Doane, J. F. 1980. Prothetely in a larva of *Limonius californicus* (Coleoptera: Elateridae). Coleopt. Bull. 34(3):333-335.

Doane, J. F. 1981. Evaluation of a larval trap and baits for monitoring the seasonal activity of wireworms in Saskatchewan. Environ. Entomol. 10:335-342.

Duczek, L. J. 1981. Number and viability of conidia of *Cochliobolus sativus* in soil profiles in summerfallow fields in Saskatchewan. Can. J. Plant Pathol. 3:12-14.

Duczek, L. J.; Buchan, J. A. 1981. The effect of captan seed treatment on emergence, nodulation, seed yield and seed protein content of lentils. Can. J. Plant Sci. 61:727-730 (Note).

Dueck, J.; Morrall, R. A. A.; Klassen, A. J.; Vose, J. 1981. Heat inactivation of sclerotia of *Sclerotinia sclerotiorum*. Can. J. Plant Pathol. 3:73-75.

Fay, J. P.; Cheng, K.-J.; Hanna, M. R.; Howarth, R. E.; Costerton, J. W. 1981. A scanning electron microscopy study of the invasion of leaflets of a bloat-safe and a bloat-causing legume by rumen microorganisms. Can. J. Microbiol. 27:390-399.

Fredeen, F. J. H. 1981. The seven larval instars of *Simulium (Phosterodoros) luggeri* (Diptera: Simuliidae). Can. Entomol. 113:161-165.

Goplen, B. P. 1981. Norgold—a low coumarin yellow blossom sweetclover. Can. J. Plant Sci. 61:1019-1021 (Note).

Goplen, B. P.; Greenshields, J. E. R. 1981. Cree birdsfoot trefoil. Can. J. Plant Sci. 61:163-165.

Gutek, L. H.; Woods, D. L.; Clark, K. W. 1981. Identification and inheritance of pigments in wild rice. Crop Sci. 21:79-82.

Hutcheson, D. S.; Downey, R. K.; Campbell, S. J. 1981. Performance of a naturally occurring subspecies hybrid in *B. campestris* L. var. *oleifera* Metzg. Can. J. Plant Sci. 61:895-900.

Kirkland, K. J.; Keys, C. H. 1981. The effect of snow trapping and cropping sequence on moisture conservation and utilization in west-central Saskatchewan. Can. J. Plant Sci. 61:241-246.

Lee, Y. W.; Westcott, N. D. 1981. Gas chromatographic quantitative analysis and persistence of dimethoate and dimethoxon residues on and in wheat plants. J. Agric. Food Chem. 29:860-862.

Lees, G. L.; Howarth, R. E.; Goplen, B. P.; Fesser, A. C. 1981. Mechanical disruption of leaf tissues and cells in some bloat-causing and bloat-safe forage legumes. Crop Sci. 21:444-448.

McGregor, D. I. 1980. The nature of hail injury to rapeseed. Can. J. Plant Sci. 60:1441-1449.

McGregor, D. I. 1981. Pattern of flower and pod development in rapeseed. Can. J. Plant Sci. 61:275-282.

McKinlay, K. S. 1981. The importance of dry plant material in the diet of the grasshopper *Melanoplus sanguinipes* (Orthoptera: Acrididae). Can. Entomol. 113:5-8.

McKinlay, K. S.; Burrage, R. H. 1980. Selecting wireworm (Coleoptera: Elateridae) control chemicals by *Drosophila* (Diptera: Tephritidae) bioassay. Can. Entomol. 112:1305-1308.

Mukerji, M. K.; Ewen, A. B.; Craig, C. H.; Ford, R. J. 1981. Evaluation of insecticide-treated bran baits for grasshopper control in Saskatchewan (Orthoptera: Acrididae). Can. Entomol. 113:705-710.

Olfert, O. O.; Olfert, M. R.; Mukerji, M. K.; Gage, S. H. 1981. Economic considerations in grasshopper control for protection of small grain crops. Can. J. Agric. Econ. 29:303-316.

Redhead, S. A.; Smith, J. D. 1981. A North American isolate of *Coprinus kubickae* associated with a superficial fairy ring. Can. J. Bot. 59:410-414.

Smith, J. D. 1981. Snow molds of winter cereals: guide for diagnosis, culture, and pathogenicity. Can. J. Plant Pathol. 3:15-25.

Miscellaneous

Burgess, L. 1981. Attractant trap for cruciferfeeding flea beetles. Canadex 620.

Burgess, L. 1981. Flea beetles that attack rape and cruciferous garden crops in the Prairie Provinces. Canadex 622.

Burgess, L. 1981. Occurrence of flea beetles outside the western rape growing area. Canadex 620.149.

Doane, J. F. 1981. A bait-trap for wireworms. Can. Agric. 26(2):31-33.

Ewen, A. B. 1981. Recent biological and chemical strategies for grasshopper control in Canada. Proc. 3rd Simp. Int. Acridologia & 4th Congr. Latinoam. Entomol., Maracay, Venezuela. 7 pp.

Knowles, R. P. 1981. Comparison of native and introduced grasses in Western Canada. Canadex 127.

McKinlay, K. S.; Ford, R. J. 1981. Pesticide application: A selected bibliography. Agric. Can., Res. Branch. 115 pp.

Mukerji, M. K.; Braun, M. P. 1981. Grasshopper outbreak forecast for the Prairie Provinces—1981. Canadex 620.

Research Station
Swift Current, Saskatchewan

PROFESSIONAL STAFF

Administration

W. L. Pelton, B.S.A., M.S.A., Ph.D.	Director
A. W. Strachan	Administrative Officer

Analytical Services

G. E. Winkleman, B.Sc.	Head of Section; Chemist
H. W. Moen[1]	Computer Systems Administration
K. E. Wilton,[2] B.A., M.L.S.	Librarian

Cereal Production and Utilization

T. F. Townley-Smith, B.S.A., M.Sc., Ph.D.	Head of Section; Cereal breeding
D. R. Cameron, B.Sc., M.Sc., Ph.D.	Production systems
J. M. Clarke, B.Sc. (Agr), M.Sc., Ph.D.	Harvest physiology
R. M. De Pauw, B.A., M.Sc., Ph.D.	Wheat breeding
K. E. Dunkelgod, B.S., M.S., Ph.D.	Turkey nutrition
D. G. Green, B.S.A., M.S., Ph.D.	Cereal physiology
T. N. McCaig, B.Sc., M.Sc., Ph.D.	Quality physiology
J. G. McLeod, B.Sc. (Agr.), M.Sc., Ph.D.	Rye breeding
R. E. Salmon, B.S.A., M.S.A., Ph.D.	Turkey nutrition

Engineering

W. Nicholaichuk, B.E., M.Sc., Ph.D.	Head of Section; Hydrology
D. W. Campbell, B.E., M.Sc., Ph.D.	Energy engineer
F. B. Dyck, B.E., M.Sc.	Senior design engineer
Y.-W. Jame, B.Sc., M.Sc., Ph.D.	Forage irrigation
N. B. McLaughlin,[3] B.Sc., M.Sc.	Design engineer
M. A. Stumborg, B.E.	Energy engineer

Forage Production and Utilization

T. LAWRENCE, B.S.A., M.Sc., Ph.D.	Head of Section; Grass breeding
P. G. JEFFERSON, B.Sc., M.Sc.	Production physiology
J. E. KNIPFEL, B.S.A., M.Sc., Ph.D.	Nutrition
J. LOOMAN, B.Sc., M.Sc., Ph.D.	Range ecology

Soil and Environment

C. A. CAMPBELL, B.S.A., M.S.A., Ph.D.	Head of Section; Soil chemistry and fertility
V. O. BIEDERBECK, B.S.A., M.Sc., Ph.D.	Soil microbiology
H. R. DAVIDSON, B.Sc., Ph.D.	Agrometeorology
A. J. LEYSHON, B.Sc., M.Sc.	Forage management
R. P. ZENTNER, B.S.A., M.Sc., Ph.D.	Economics

Departures

E. A. HURD, B.S.A., M.S., Ph.D. Retired 13 November 1981	Wheat breeding
R. B. IRVINE, B.S.A., Ph.D. Transferred to Agriculture Canada Research Station, Brandon, Man., 27 September 1981	Legume breeding
M. R. KILCHER, B.S.A Retired 29 December 1981	Pasture management
D. S. MCBEAN, B.S.A., M.Sc. Retired 24 July 1981	Rye breeding
P. I. MYHR, B.S.A. Retired 29 December 1981	Information Officer
D. W. L. READ, B.S.A., M.Sc. Retired 18 December 1981	Cereal fertility
F. G. WARDER, B.S.A., M.Sc. Retired 26 March 1981	Soil chemist

[1]Seconded from Systems and Consulting Division, Finance and Administration Branch.
[2]Seconded from Libraries Division, Finance and Administration Branch.
[3]On educational leave.

INTRODUCTION

The diversified research program at the Swift Current Research Station emphasizes the improvement of cereal and forage cultivars and the development of technology to improve crop production and utilization practices. This is accomplished through a multidisciplinary approach to research in plant breeding, plant physiology, agronomy, soil and water management, salinity control, nutrition, agrometeorology, agricultural engineering, and energy.

During 1981, new cultivars of hard red spring wheat (Leader) and alfalfa (Heinrichs) were licensed. The former combines for the first time resistance to the wheat stem sawfly with a long seed dormancy period and a desirably low level of α-amylase activity. The latter provides a forage yield advantage over other alfalfa cultivars suited to the southern prairies while maintaining good winterhardiness. Studies of seeding, fertilization, and harvesting have led to improved crop management recommendations. Free amino acids in the plasma of poults can be used as an indicator of possible limiting amino acids in protein sources for poultry diets. New equipment was developed for several research stations and, in addition, Station scientists managed 22 research and development contracts.

These and other research accomplishments are described briefly in this report. More detailed information can be obtained from the publications listed at the end of this report or from individual scientists. Requests and correspondence should be addressed to the Research Station, Research Branch, Agriculture Canada, Box 1030, Swift Current, Sask. S9H 3X2.

W. L. Pelton
Director

CEREAL PRODUCTION AND UTILIZATION

Leader—A new sawfly-resistant spring wheat

The hard red spring wheat line BW 535 was licensed as the cultivar Leader. Leader is the first cultivar that combines resistance to the wheat stem sawfly with a long seed dormancy period. Even in the absence of sprouting, sawfly-resistant wheats have higher levels of α-amylase activity than other wheats; this characteristic in Chester has caused serious concern on the hard red spring wheat market. Leader is the first sawfly-resistant wheat with lower levels of α-amylase than Neepawa. Sawfly-resistant wheats have traditionally been more susceptible to sprouting before combine-harvesting than hollow-stemmed hard red spring cultivars. Leader yields about 3% more than Chester and about 5% more than Neepawa in the Brown soil zone of Saskatchewan. Leader has good resistance to stem rust and loose smut, and moderate resistance to leaf rust, bunt, and root rot. The overall bread-making quality is good.

Progress continues toward the development of high-yielding white wheats with medium kernel hardness, medium protein content, and medium gluten strength. Several white-seeded lines have been developed with an increased dormancy period.

Cereal harvesting

The soft spring wheat (*Triticum aestivum* L.) cultivars Dirkwin and Fielder and the hard red spring wheat cultivar Neepawa were grown under irrigation for 2 yr. Plots were harvested at seven kernel moisture contents (KMC) ranging from 45 to 15%. Material was dried in the field (windrowed) or artificially dried in a forced-air oven at 50°C after threshing. Yield, test weight, 1000-kernel weight, grain N, falling number (inverse of α-amylase), and commercial grade were determined.

Yield and grain N content were not affected by cutting time or drying method. Test weight of artificially dried material increased as cutting was delayed until lower KMC values were reached. In the windrowed treatment, test weight of Neepawa changed very little with cutting time whereas that of Dirkwin and Fielder increased to a maximum at 25% KMC. The 1000-kernel weights of the

cultivars increased as KMC decreased in 1 of the 2 yr. Falling number was constant for all cutting times in the windrowed treatment, but increased linearly as KMC at harvest decreased in the artificially dried treatment. Commercial grades in the windrowed material had reached maximum by 35% KMC in all three cultivars. In the artificially dried material, maximum grades were not obtained unless cutting was delayed until KMC values of 20% or less were reached. Material cut at higher KMC levels lost grade because of the presence of immature kernels and low test weight.

Rye breeding and genetics

Genes for the dwarfing of rye have been incorporated into adapted tall materials. Three sources of dwarfing were used: Moscow dwarf, Bulgarian dwarf, and a Polish dwarf selection. The Polish and Bulgarian sources resulted in about a one-third reduction in plant height, but Moscow dwarf resulted in little height reduction. All appeared to be simply inherited (one gene). The Polish and Bulgarian dwarfing sources are of most interest for plant breeding as they result in a desirable spike and plant morphology, whereas the spike of the Moscow dwarf is compact and susceptible to shattering and the culms are brittle and break easily.

In cooperation with pathologists at the Lethbridge Research Station, Puma/Cougar, Puma/Kodiak, and Puma/Cougar//Puma/Kodiak populations were screened for resistance to stem rust (*Urocystis occulta*). Resistance appears to be simply inherited, as evidenced by the high frequency of resistant plants in the segregating populations. The populations of Puma/Kodiak and Puma/Cougar//Puma/Kodiak had the highest frequency of resistant segregates, as expected. Kodiak was the most resistant parent and Cougar the least. Many of these segregates have displayed resistance for two generations.

Data acquisition

Inexpensive portable microcomputers that facilitate the collection and storage of experimental data are now available. However, a problem often exists in matching the output [for example, analog voltage or binary coded decimal (BCD)] of field or laboratory instruments with the input requirements of the microcomputer.

Two interfaces were therefore developed at the Swift Current Research Station to allow data to be directly transmitted from a laboratory balance and field thermometers (infrared and thermistor) to a portable microcomputer. The balance was equipped with parallel BCD output whereas the thermometers had an analog voltage output. Both outputs were converted to EIA RS-23ZC/ASCII standards that are common on most microcomputers today. Both interfaces employed CMOS integrated circuits that are excellent for battery operation because of their very low power requirements. Interfaces such as these are relatively easy to construct and materials are readily available and inexpensive.

Indicator of limiting amino acids in protein sources

Free amino acids in the plasma of poults were used to determine possible limiting amino acids in turkey starter diets that incorporated each of four currently available protein sources (pea protein concentrate, dehulled soybean meal, herring fish meal, and poultry residue meal). The diets were compared with a control diet, containing fish meal and soybean meal, which has been consistent in producing maximum growth with lower free amino acid levels in the blood plasma of poults in our laboratory.

The diet that contained pea protein concentrate plus added methionine produced significantly lower plasma levels of methionine, arginine, proline, threonine, leucine, and taurine than the control values. The addition of threonine to the methionine-supplemented pea protein concentrate significantly reduced the free isoleucine and leucine in the plasma.

Soybean meal with methionine failed to produce a weight gain equal to that from the control diet; a lysine supplement improved growth rate and threonine was the next limiting amino acid.

The poults fed the herring fish meal diet with no amino acid supplementation produced a growth rate equivalent to the control birds. Free methionine was significantly lower, which indicated a lower level of available methionine in the fish meal.

Supplementation of 26% poultry residue meal with methionine and lysine improved growth rate, but further addition of histidine or histidine and tyrosine resulted in no further improvement. The free amino acids in the plasma indicated that methionine, lysine,

histidine, leucine, and isoleucine were limiting in the poultry residue meal studied.

ENGINEERING

Equipment design

Equipment was designed and constructed to meet some of the research needs of three research stations in the Western Region.

A six-row pull-type plot seeder was developed for the Saskatoon Research Station. It features a cab and overall weight-saving design that reduce draft requirements. The plot seeder can be readily pulled by the heavier imported Japanese garden tractors such as a 9- to 11-kW Kabota, Yanmar, or similar tractor.

A soil/root washer for the Morden Research Station was produced to facilitate the separation of sclerotia from soil. It can handle eight samples simultaneously (up to 8 L in volume) and may also be used to separate roots from soil.

A straw chopper for the Hege plot combine was developed for the Regina Research Station.

Loss of 2,4-D in snowmelt runoff

Fall spraying of 2,4-D for the control of winter annuals, a recommended practice in Western Canada, may be considered a potential source of pollution in spring runoff.

Based on 6 yr of study, the weighted mean concentrations of 2,4-D in spring runoff were lower than those reported by researchers engaged in monitoring the quality of rainfall runoff for grassed waterways and corn fields. The average loss of 31 g/L represents 2.7% of the total amount applied. The total annual loss appears to be a linear function of runoff volume.

In terms of allowable losses, the weighted mean is well below the maximum permissible level of 100 g/L set by National Health and Welfare (1969), or slightly above the U.S. NAS/NAE (1973) objective of 20 g/L for drinking water standards.

Boron concentration in the soil solution under irrigation

Current irrigation water criteria for boron are based upon the B concentration in either the irrigation water or the soil saturation extract. The effects of the leaching fraction (LF) and the boron adsorption capacity (BAC) of the soil upon the soil solution concentration have not been considered. A study was undertaken to develop a predictive model relating soil-solution B concentration at equilibrium to the B concentration in irrigation water and the LF. The aim was also to show how to model the relationship between the B concentration of the soil solution under field conditions and the B concentration of the soil saturation extract. The predictive model, derived from the mass balance concept, indicated that at equilibrium the value of soil-solution B in well drained soil would be close to that of irrigation water at the soil surface and would increase with depth, with the highest value near the bottom of the root zone where its magnitude is determined mainly by the degree of leaching. For irrigation-water B concentrations between 0.5 and 10 mg/L, the weighted average B concentration of the soil solution in the profile of an alfalfa field would be about 1.9–2.7 times the irrigation-water concentration at a LF of 0.1; it would be 1.4–1.9 times for a LF of 0.25, and 1.3–1.5 times for a LF of 0.4. The model of the relationship between soil-solution B at field capacity and saturation-extract B indicates the importance of the BAC of the soil. Without considering BAC, the ratio between the two would be 2. However, the model indicates that the ratio ranges from 1.0 to 1.8 depending upon the B concentration in the solution and BAC of the soil. This suggests that the B concentration of the soil saturation extract does not provide a true representation of the soil-solution B. In assessing B toxicity, the saturation-extract concentration should be converted to the soil-solution concentration at the actual water content of the soil.

Contract research

The Agricultural Engineering Research and Development (AERD) contract program has made significant achievements during the past year toward the development of automatic depth control, zero-tillage seeding, and big-bale stacking equipment.

An automatic depth controller, under development by Sakundiak Bros. of Sedley, Sask., and more recently by Inventronics of Brandon, is now in commercial production. Last year, 10 preproduction prototypes were tested and final modifications were made; 100 units are now being produced and will be on the market in 1982. Development of this unit is timely as it will improve the performance of

cultivator-mounted "air" seeders and help to make them a viable seeding implement for cereal production in the Great Plains area of North America.

Research and development in equipment for the zero-tillage seeding of cereals has been carried out by the Versatile-Noble Company for a number of years. During 1981, two preproduction prototype seed drills with hoe openers and two with disc openers were tested. The hoe drill with narrow zero-tillage points performs very well under conditions of moderate crop residue but becomes plugged in heavy residue. The drill with disc openers performs well in heavy crop residue and disturbs the soil much less than the hoe openers. The hoe drill with zero-tillage points is currently available on the market. A zero-tillage disc-type drill is scheduled for production in late 1982 or 1983.

Olds Ag-Tech Industries has successfully developed a transporter and stacker for large round bales. During 1981 a six-bale prototype was successfully demonstrated. It can pick up, transport, and stack six large round bales (up to 900 kg each) in 15–20 min in a short-haul situation. A more economical four-bale unit has been produced and will be extensively tested during 1982. The units can also retrieve and unroll the bales for feeding.

FORAGE PRODUCTION AND UTILIZATION

Heinrichs—A new alfalfa

Heinrichs is a new cultivar of alfalfa released in 1981. It was developed from a recurrent selection program for leaf-to-stem ratio within crosses among Rambler, Roamer, their parental stocks, and five introductions of *Medicago sativa* L. from the USSR. Large vigorous plants were selected and subsequently screened for resistance to bacterial wilt. Yield trials indicate that Heinrichs produces 10% more forage than Rambler and 6% more than Drylander. It approaches Beaver in dry matter production and is equal to Rambler in winterhardiness. It is well adapted for hay production in the Brown and Dark Brown soil zones of Saskatchewan and Alberta.

Yield and digestibility of grasses

The effects of three rates of N fertilizer and nine dates of initial harvest on the dry matter (DM) yield, recovery, organic matter digestibility (OMD), and yield of digestible organic matter (DOM) of crested wheatgrass [*Agropyron desertorum* (Fisch.) Schult.], Russian wild ryegrass (*Elymus junceus* Fisch.), and Altai wild ryegrass (*Elymus angustus* Trin.) were studied on irrigated land for 2 yr. Russian wild ryegrass produced the highest yield in May, whereas the yield of crested wheatgrass equaled that of Russian wild ryegrass in June. Altai wild ryegrass yielded more dry matter than either Russian wild ryegrass or crested wheatgrass in July and August. Altai wild ryegrass showed the best recovery after cutting and produced the highest total DM yield. Crested wheatgrass had the lowest and Altai wild ryegrass the highest OMD. Nitrogen fertilizer application resulted in increased DM yield, increased OMD, and higher yield of DOM.

Nitrate accumulation in grasses

The effects of three rates of N fertilizer and nine dates of initial harvest on the nitrate content of Altai wild ryegrass (*E. angustus*), Russian wild ryegrass (*E. junceus*), and crested wheatgrass (*A. desertorum*) were studied on irrigated land for 2 yr. The nitrate content of the forage of all three grasses increased with increasing rates of N fertilizer and varied with date of harvest. Toxic levels of nitrates (>2000 mg/kg) were found in forage of all three grasses fertilized with N at 400 kg/ha. Altai wild ryegrass accumulated toxic levels of nitrates more readily than Russian wild ryegrass, and both ryegrasses accumulated toxic levels more readily than crested wheatgrass. Toxic levels of NO_3-N can thus be expected in Altai and Russian wild ryegrass fertilized with N at 400 kg/ha, but crested wheatgrass fertilized at similar rates should have toxic levels for only a short period, if at all.

Curing quality of grasses

Over an 8-yr period from 1973 to 1980, changes in the nutritional value of crested wheatgrass, Russian wild ryegrass, and Altai wild ryegrass were studied from May to December. Laboratory analyses indicated that the nutrient contents of all three grasses declined with advancing maturity, with the

decline in nutrient content of crested wheatgrass being somewhat more rapid than that of the two ryegrasses. Nitrogen fertilization increased the N contents of all three grasses at early cutting stages but had no effect upon in vitro OMD and decreased the P level of the forage. Supplementation of the three grasses with urea or P, or both, increased in vitro OMD, with more pronounced increases occurring in more mature forage. Associated with increased in vitro digestibilities were altered patterns of gas production as measured by respirometer. In vivo studies showed that the ryegrasses were markedly superior to crested wheatgrass as they matured because animal intake did not decrease for the former nearly as much as for the latter, even though digestibility measurements were similar for the three species. Also, the in vivo studies did not show significant increases in nutritive value caused by supplementation of the grasses with urea or P, whereas ammoniation of more mature cuts increased nutritive value markedly. These data clearly demonstrate the importance of in vivo experiments in assessing nutritive value of potential forage species.

Ammoniation of wheat straw and chaff

A number of studies have been conducted from 1977 to the present to assess the potential for improving the nutritional value of straw or chaff, and thus the amount used in overwintering rations for ruminants. After ammoniation, the digestibility of both straw and chaff was improved approximately 20%, or 10 digestible units, and the intake of digestible energy increased by 30% (straw) to 50% (chaff). Chaff was higher than the corresponding straw in nutritive value, and depending upon the proportion of weed seeds, cracked grain, or unthreshed heads, could approach the digestible energy contents of high-quality hays following ammoniation. Pregnant beef cows maintained over winter on a diet of ammoniated straw free choice plus 2 kg oats per day exhibited weight gains significantly higher than those achieved by cows fed 10 kg of brome–alfalfa per head daily. These studies, undertaken in cooperation with the Saskatchewan Research Council, have demonstrated that ammoniation of crop residue may provide an economical means of improving the nutritive value of the winter feed supply based mainly on crop residue.

Vegetation surveys and classification

In 1981 the study of semiaquatic vegetation was concluded and the classification of these vegetation types completed. This classification shows strong affinities with similar plant communities in Eurasia, with several species and genera common to North America and Eurasia. The classification shows that plant communities considered indicative of water or soil pollution in Europe have the same indicative value here. An aquatic species, *Wolffia arrhea* (L.) Wimm., water-meal, new to the Prairie Provinces and Canada, was found first in a slough north of Pierceland, Sask. A survey of several sloughs and lakes showed its presence in two other bodies of water: a slough south of Prince Albert, Sask., and a lake near Perigord, Sask. Although a very small plant, it can be of importance as food for waterfowl and together with the larger duckweeds can completely cover the surface of the water, thus making the water unsuitable for mosquito larvae.

SOILS AND ENVIRONMENT

Biocycling of phosphorus in soil by plant roots

Plants circulate nutrients in soil by bringing minerals from the subsurface to the surface soil. It was shown that P, a relatively immobile nutrient, can be moved to the subsoil by the roots under cereals that have received high rates of P. Residual effects of P fertilizer have been studied at Swift Current, Sask., since 1966. Single applications of P at 0, 100, 200, and 400 kg/ha were applied in 1966. Soil samples taken in the fall of 1967, 1974, and 1979 showed that there was more $NaHCO_3$-extractable P under the fertilized plots than under the unfertilized plots. At depths below 30 cm the differences were greater in 1979 than in 1974, particularly under the 400 kg/ha treatment. This indicates a gradual downward movement of P, probably in the tissue of the plant roots.

Soil microbial and nitrogen changes

Much of the plant-available nutrients in soil, especially mineral N, are controlled by soil microbial activity. The nutrients and the microbes are in a dynamic state that is mainly controlled by environmental factors.

The response of microbes and mineral N to changing environmental conditions in the field

was measured year-round by frequently sampling the 0–2.5, 2.5–15, and 15–30 cm depths of a Brown Chernozemic soil under a wheat–fallow rotation. The results of this study have enhanced the interpretation of microflora–soil fertility interactions by demonstrating (*a*) the stepwise nature of the ammonification–nitrification process; (*b*) the importance of crop residues in enhancing microbial growth and N losses via denitrification; (*c*) the flush in microbial growth that results when a dry soil is moistened; and (*d*) the prime site of soil microbial activity as being the tilled layer, with microbial numbers and activity decreasing sharply below this layer.

Soil nitrogen mineralization and soil moisture

Plant intake and use of N are in part a function of the ability of the soil to supply the element to the plant. Plant-available N is produced by mineralization of soil organic N, a process that is modified by soil temperature and moisture. Definition of the relationships between the moisture and temperature of the soil and the N mineralization rate is necessary for the development of models of soil N mineralization. Such models can be used as an aid to predicting plant response to N fertilizer.

The relationship between net N mineralization and soil water in five soil types from Queensland, Australia, and 18 soil types from Western Canada was investigated to derive a universal equation or set of equations for use in mathematical modeling.

Samples from 0–15 and 15–30 cm depths of the soils were incubated at a range of moisture contents for 14 days at 35°C. In most soils, net N mineralization was linearly related to moisture content in the available range for wheat (–0.03 to –4.0 MPa). Optimum moisture for net N mineralization was between –0.01 and –0.03 MPa (field capacity), whereas that at which no net N mineralization occurred was close to –4.0 MPa (permanent wilting point for wheat). By normalizing (expressing in relative terms) the N mineralized against available moisture (between –0.03 and –4.0 MPa) we succeeded in grouping the soils. The response of all soils could be described by a model of the form: $y = bx(1 - b)x^2$ constrained to pass through x_0y_0 and x_1y_1 when both axes were scaled through 0 and 1. In the equation, y is net mineralized N expressed as a proportion of the maximum rate; x is normalized moisture content; and the subscripts 1 and 0 refer to water potentials of –0.03 and –4.0 MPa, respectively. Almost all data conformed to this model.

Drilling fertilizer into established alfalfa

Drilling fertilizer into an established forage crop grown under semiarid conditions has been suggested as a means of increasing fertilizer availability, because the fertilizer would be in moist soil for a longer period of time. Experiments were conducted on an Orthic Brown Chernozemic soil to determine the effects of fertilizer rate and placement depth on the yield of an established dryland alfalfa (*Medicago* ×*varia* Martyn) stand. In one experiment, P fertilizer at rates up to 64 kg/ha was drilled in to depths of 0, 5, and 10 cm and in a second experiment, N fertilizer at rates up to 200 kg/ha was drilled in to the same depths. Fertilizer rate did not affect yields in either experiment and there were no interactions between placement depth and fertilizer rate. However, in both experiments, increasing the placement depth decreased yields between 12 and 20% in the 1st yr and in both experiments the yield decreases persisted for 2 yr longer. In a third experiment the soil 30 cm from the row of an old established stand of alfalfa was disturbed at four depths (0, 2.5, 5, and 10 cm) with a tractor-drawn spike to simulate a fertilizer drill. A 20% decrease in yield was observed when the soil was disturbed below 2.5 cm. It is suggested that the reduced yields were a result of mechanical damage to roots and that the persistence of the effect was due to the inability of the root to regrow in the dry topsoil common to southwestern Saskatchewan. It is recommended that all fertilizer be surface-applied on established alfalfa stands.

Growing sunflowers in southwestern Saskatchewan

Sunflower is a possible alternative crop to hard red spring wheat in semiarid southwestern Saskatchewan. A study was carried out to determine the proper row spacing at which this crop should be grown. At the same time, it was necessary to determine whether sunflowers would leave sufficient residues to protect the soil from wind erosion while encouraging overwinter snow conservation. Sunflowers were grown on summerfallow at row spacings of 18, 36, and 53 cm, with and

without P fertilizer, over a 5-yr period. Hard red spring wheat was grown for comparison. A row spacing of 36 cm produced greater sunflower yields than did row spacings of 18 or 53 cm. Fertilizer increased the yield of 18-cm spacing slightly only in wet years. Yield of wheat was 1.9–3.5 times as great as that of sunflowers. Sunflowers had no deleterious effect on the yield of a subsequent wheat crop. There was no difference between sunflowers and wheat regarding their effect on soil erosiveness or water and N use.

Technique for locating sampling sites

It is usually difficult to locate specific sampling sites a second time in fields. Many methods have been used, including metal detectors, permanent stakes, and measurement from benchmark sites. A new system has been developed that has advantages over all these methods. It consists of a peg (transponder) that can be buried below cultivation depth and an easily operated radio detector that can locate the peg from approximately 2 m distance and home in on the exact position. The accuracy is within 5 cm when the peg is buried at a 1-m depth. The equipment is of sturdy construction and the pegs remain usable for many years.

Residual effects of nitrogen fertilizer

Grasses respond to N fertilizer when moisture is not limiting, but moisture can often limit growth in semiarid areas before soil N becomes a limiting factor. It is difficult to define a fertilizer program when the amount of moisture available for plant growth cannot be predicted and is highly variable. Heavy rates of P fertilizer can be applied to the soil and the fertilizer remains available for plant use for several years. Phosphorus remains adsorbed to the soil particles and is not as easily removed by leaching as N is. If N could be added in one large application and stored in the soil for long periods it would be available for plants to use in times of adequate moisture, which often occur in the early spring before the application of fertilizer is possible. Another advantage is the reduced labor cost of a single application as compared with several treatments annually.

Nitrogen at rates of 0, 50, 100, 400, and 800 kg/ha, with and without P at 44 kg/ha, was broadcast on old stands of crested wheatgrass, *Agropyron cristatum* (L.) Gaertn., on two soils in southwestern Saskatchewan. A pool of residual N developed in the soil under the 400- and 800-kg treatments and remained available to the crop for up to 10 yr. The yield and N content of the forage were increased by the residual N when moisture was adequate. In clay loam there was no indication that any N moved down beyond 120 cm in the soil; most was held in the 30–90 cm depth. On sandy loam soil there may have been some movement beyond 120 cm. Even from the lower rates of N application, where there was no pool of residual mineral N, the yields have been consistently higher than from the control plots, indicating a possible slow release of N from the biomass. Phosphorus remained available for 10 yr. The recovery rates for N ranged from 97 to 22%, and for P they were 51 and 61% of the applied nutrient.

PUBLICATIONS

Research

Cameron, D. R.; De Jong, E.; Read, D. W. L.; Oosterveld, M. 1981. Mapping salinity using resistivity and electromagnetic inductive techniques. Can. J. Soil Sci. 61:67-78.

Campbell, C. A.; Davidson, H. R.; Winkleman, G. E. 1981. Effect of nitrogen, temperature, growth stage and duration of moisture stress on yield components and protein content of Manitou spring wheat. Can. J. Plant Sci. 61:549-563.

Campbell, C. A.; Myers, R. J. K.; Weier, K. 1981. Nitrogen mineralization potentials, decomposition rates and their relationship to temperature for five Queensland soils. Aust. J. Soil Res. 19:323-332.

Campbell, C. A.; Nicholaichuk, W.; Biederbeck, V. O.; Ukrainetz, H.; Bole, J. B. 1981. An empirical method of estimating soil temperature on cropped land on Canadian prairies. Can. J. Plant Sci. 61:565-573.

Clarke, J. M. 1981. Effects of delayed harvest on shattering losses in oats, barley and wheat. Can. J. Plant Sci. 61:25-28.

Clarke, J. M. 1981. Effect of harvest time and drying method on quality and grade of irrigated soft white spring wheat. Can. J. Plant Sci. 61:803-810.

Clarke, J. M. 1981. Effect of diquat, paraquat and glyphosate on pre-harvest drying of wheat. Can. J. Plant Sci. 61:900-913.

Coxworth, E. W.; Kernan, J.; Knipfel, J. E.; Thorlacius, O.; Crowle, L. 1981. Review: Crop residues and forages in Western Canada: Potential for feed use either with or without chemical or physical processing. Agric. Environ. 6:245-256.

De Pauw, R. M.; Faris, D. G.; Williams, C. J. 1981. Genotype–environment interaction of yield in cereal crops in northwestern Canada. Can. J. Plant Sci. 61:255-263.

De Pauw, R. M.; Hurd, E. A.; Patterson, L. A. 1981. Registration of Sinton wheat. Crop Sci. 21:799.

De Pauw, R. M.; McBean, D. S. 1981. Registration of Canuck wheat. Crop Sci. 21:798-799.

Faris, D. G.; De Pauw, R. M. 1981. Effect of seeding rate on growth and yield of three spring wheat crops. Field Crops Res. 3:289-301.

Hidiroglou, M.; Knipfel, J. E. 1981. Maternal–fetal relationships of copper, manganese and sulfur in the ruminant—A review. J. Dairy Sci. 64:1637-1647.

Jame, Y. W.; Nicholaichuk, W.; Kilcher, M. R. 1981. Soil salinity: Effluent irrigation vs. creek water irrigation. Can. Agric. Eng. 23:31-35.

Kilcher, M. R. 1981. Plant development, stage of maturity and nutrient composition. J. Range Manage. 34:363-364.

Knipfel, J. E. 1981. Nitrogen and energy availabilities in foods and feeds subjected to heating. Prog. Food Nutr. Sci. 5:177-192.

Knipfel, J. E.; Kernan, J. A.; Coxworth, E. W. 1981. Digestibility and voluntary intake by wethers of diets containing ammoniated or high pressure steam treated Neepawa wheat straw from fields fertilized with manure or chemical fertilizer. Can. J. Anim. Sci. 61:657-662.

Lawrence, T. 1981. Clarke intermediate wheatgrass. Can. J. Plant Sci. 61:467-469.

Lawrence, T.; Knipfel, J. E. 1981. The yield and digestibility of crested wheatgrass, Russian wild ryegrass and Altai wild ryegrass as influenced by N fertilization. Can. J. Plant Sci. 61:609-618.

Lawrence, T.; Winkleman, G. E.; Warder, F. G. 1981. Nitrate accumulation in Altai wild ryegrass, Russian wild ryegrass, and crested wheatgrass. Can. J. Plant Sci. 61:735-740.

Leyshon, A. J.; Kilcher, M. R.; McElgunn, J. D. 1981. Seeding rates and row spacings for three forage crops grown alone or in alternate grass–alfalfa rows in southwestern Saskatchewan. Can J. Plant Sci. 61:711-717.

Looman, J. 1981. The vegetation of the Canadian Prairie Provinces: II. The grasslands. Part 2. Mesic grasslands and meadows. Phytocoenologia 9:1-26.

Looman, J. 1981. The vegetation of the Canadian Prairie Provinces: III. Aquatic and semi-aquatic vegetation. Part 1. Salt marshes and salt meadows. Phytocoenologia 9:473-497.

McLeod, J. G.; McBean, D. S.; Buzinski, S. R. 1981. Musketeer winter rye. Can. J. Plant Sci. 61:993-994.

Read, D. W. L.; Campbell, C. A. 1981. Biocycling of phosphorus in soil by plant roots. Can. J. Soil Sci. 61:587-589.

Salmon, R. E.; Gardiner, E. E.; Klein, K. K.; Larmond, E. 1981. Effect of canola (low glucosinolate rapeseed) meal, protein and nutrient density on performance, carcass grade and meat yield, and of canola meal on sensory quality of broilers. Poult. Sci. 60:2519-2528.

Spratt, E. D.; Warder, F. G.; Bailey, L. D.; Read, D. W. L. 1980. Measurement of fertilizer phosphorus residues and its utilization. Soil Sci. Soc. Am. J. 44:1200-1204.

Miscellaneous

Biederbeck, V. O.; Waker, B. D. 1981. PEPI: An improved plant infection technique for enumeration of rhizobia. Proc. 8th North Am. Rhizobium Conf., Aug. 1981, Winnipeg, Manit. 14 pp.

Clarke, J. M. 1981. Screening of *Triticum* genotypes for excised leaf water retention capability. *In* Proc. Am. Soc. Agron. Annu. Meet., Atlanta, GA.

Clarke, J. M.; Durley, R. C. 1981. The responses of plants to drought stress. Pages 89-139 *in* Simpson, G. M., ed. Water stress in plants. Praeger Scientific, New York, N.Y.

Clarke, J. M.; Karamanos, A. J.; Simpson, G. M. 1981. Case examples of research progress in drought-stress physiology. Pages 140-234 *in* Simpson, G. M., ed. Water stress in plants. Praeger Scientific, New York, N.Y.

Coxworth, E. W.; Kernan, J.; Knipfel, J. E.; Crowle, L. 1981. Assessment and improvements of the feed performance of treated chaff and straw with or without alkali treated whole grain. Sask. Res. Counc. Publ. No. C-814-7-B-81. 108 pp.

Kernan, J.; Knipfel, J. E. 1981. Ammoniation of straw and chaff. Publ. 453, Univ. of Sask. 6 pp.

Kernan, J.; Knipfel, J. E.; Coxworth, E. W.; Spurr, D. T. 1981. A comparison of ammoniated and untreated Neepawa wheat straw collected from fields fertilized with pig manure and synthetic fertilizer. Sask. Res. Counc. Publ. No. C-814-11-E-81. 53 pp.

Kilcher, M. R. 1981. Watered lawns in S.W. Saskatchewan. Agric. Can. Res. Stn., Swift Current, Sask. Mimeogr. Bull. 105. 9 pp.

Lawrence, T. 1981. Clarke intermediate wheatgrass. Forage Notes 25(1):13.

Lawrence, T. 1981. Can hairs make a difference? Forage Notes 25(1):11-13.

Nicholaichuk, W. 1980. Soil water conservation research. Pages 12-14 *in* Canada Water Year Book 1979–80. Water Res. Ed.

Nicholaichuk, W. 1981. Grass barriers and swathing for snow management. Publ. No. 454, AgDex 510 (Feb. 1981), Saskatoon, Sask.

Nicholaichuk, W. 1981. Snow management on the Canadian Prairies. *In* Proc. 34th Annu. Can. Water Resour. Assoc. Conf. (June 1981), Banff, Alta.

Salmon, R. E.; Biely, J. 1981. Canola and rapeseed meal and oil in poultry and livestock rations. An annotated bibliography. Update: 1979–1980. Publ. No. 53, Supplement 2, Canola Counc. Can. Winnipeg, Manit.

Research Station
Beaverlodge, Alberta

PROFESSIONAL STAFF

L. P. S. Spangelo, B.S.A., M.Sc., Ph.D.	Director
W. H. Marshall	Administrative Officer

Cereal and Oilseed Crops

R. I. Wolfe, B.S.A., B.D., Ph.D.	Head of Section; Cereal breeding
R. S. Sadasivaiah, B.Sc., M.Sc., Ph.D.	Rapeseed

Environment and Soils

W. A. Rice, B.S.A., M.Sc., Ph.D.	Head of Section; Microbiology
A. L. Darwent, B.S.A., M.Sc., Ph.D.	Weed control
J. G. N. Davidson, B.S.F., M.Sc., Ph.D.	Plant pathology
A. M. F. Hennig, B.Sc.	Crop management
J. S. McKenzie, B.S.A., M.Sc., Ph.D.	Plant survival
P. F. Mills, B.A.	Micrometeorology
Vacant	Soil physics

Forage Crops and Apiculture

C. R. Elliott, B.Sc., M.Sc., Ph.D.	Head of Section; Grass seed management
S. G. Bonin, B.S.A., Ph.D.	Grass breeding
D. T. Fairey, B.Sc., M.Sc., Ph.D.	Legume seed physiology
N. A. Fairey, B.Sc., M.Sc., Ph.D.	Forage production
D. L. Nelson, B.S.A., M.Sc.	Head of unit; Apiculture
T. P. Liu, B.Sc., M.Sc., Ph.D.	Apicultural pathology
T. I. Szabo, B.A.E., M.Sc., Ph.D.	Apiculture

Experimental Farm, Fort Vermilion, Alta.

B. SIEMENS, B.S.A., M.Sc.	Superintendent; Forage crops management
VACANT	Crop production

Departure

W. C. BAILEY, B.Sc., Ph.D. Transferred to Land Resource Research Institute, Ottawa, March 1981	Micrometeorology

VISITING SCIENTISTS

Agricultural Research Council of Alberta

J. V. CHRISTENSEN, B.Sc.	Cereal agronomy
H. G. NAJDA, B.S.A., M.P.M.	Forage agronomy

INTRODUCTION

The Northern Research Group, which comprises the Research Station at Beaverlodge and the associated Experimental Farm at Fort Vermilion, Alta., is largely responsible for research on agricultural problems of northwestern Canada. This report presents highlights of research for 1981.

Major accomplishments include the licensing of Otal barley, a six-rowed, nonmalting cultivar received from Alaska in 1974 and advanced through the Beaverlodge breeding program for its high yield and early maturity.

The complexities of winter injury in alfalfa were further elucidated by determining that the fall-frost damage sustained by leaves is not a major factor in the winter survival of seedling alfalfa.

Techniques for identification of strains of legume inoculants were refined and the time required for testing was reduced.

Detailed information can be obtained from the publications listed in this report. Correspondence to individual research scientists should be addressed to the Research Station, Research Branch, Agriculture Canada, Box 29, Beaverlodge, Alta. T0H 0C0; and the Experimental Farm, Research Branch, Agriculture Canada, Fort Vermilion, Alta. T0H 1N0.

L. P. S. Spangelo
Director

APICULTURE

Behavior

Pollen collection by honey bees. Daily pollen samples were collected from package and wintered honey bee colonies located on the Agriculture Canada Research Station grounds, Beaverlodge, Alta., in 1977 and 1978. The colonies drew from six primary sources for 90% of their pollen in both years. Alsike clover pollen (*Trifolium repens* type) made up 47.8 and 48.0% of the total whereas rapeseed (*Brassica* spp.) pollen made up 12.3 and 13.6% of the total pollen collected in 1977 and 1978, respectively. The other four primary sources, dandelion (*Taraxacum officinale*) and hawk's-beard (*Crepis lanceolata*) in the Liguliflorae, the rose family (Rosaceae), sweet-clover (*Melilotus* spp.), and red clover (*Trifolium pratense*), varied in relative importance each year. A total of 17 and 23 pollen types (taxa) were identified in 1977 and 1978, respectively. Individual colonies showed preferences for different pollen types. Package and wintered colonies showed no differences in amounts of pollen collected in 1977; in 1978 wintered colonies collected less pollen, possibly due to poor wintering and other factors affecting colony strength.

Utilization

Dried turkey meal produced from dead bees. Dried meal, produced from bees killed after the honey-producing season, has been assessed as a high-protein feedstuff in diets of growing turkeys from 6 to 41 days of age. Although higher in crude protein and differing in amino acid composition, dried bee meal was similar to soybean meal in total amino acids and true metabolizable energy. Diets containing dried bee meal at rates of 150 and 300 g/kg linearly decreased live weight gained by poults. Efficiency of feed conversion was slightly improved when the diet contained bee meal at 150 g/kg, but was depressed by 300 g/kg. The adverse effects may be related to nonprotein nitrogen in bee meal or to toxicity of dried bee venom. This study was conducted in cooperation with the Research Station, Swift Current, Sask.

CEREALS

Breeding

Otal barley licensed. Otal barley was licensed for sale in Canada in May 1981. It is an early-maturing six-rowed nonmalting cultivar. In Alberta regional trial summaries it averaged 20% higher in yield than Olli while maturing in the same number of days. It was

9% lower yielding than Bonanza and 7 days earlier. In other agronomic characteristics and disease resistance it is similar to and somewhat better than Olli.

Otal was developed in Alaska and released there in April 1981. It was received from Alaska in 1974 and advanced through the Beaverlodge breeding program.

ENVIRONMENT AND SOILS

Meteorology

Agroclimatic resource mapping. The usefulness of computer analysis and graphics procedures for mapping agroclimatic resources in agricultural frontier areas is demonstrated for an 18 000 km² study area in the Peace River region of northwestern Alberta. Spatial climatic equations based on 1931–1960 climatic normals were used to estimate the thermal climate at 85 points that had been selected to represent the topography of the study area. Crop developement and freeze-date equations were then applied to the point estimates of thermal climate to assess the suitability for maturing barley and wheat. The results, mapped with the SYMAP computer program, indicated that wheat would mature in roughly half the study area, whereas 94% of the area was climatically suited for ripening barley. Sensitivity of the region's agriculture to changes in the thermal climate was illustrated.

Plant survival

Winter injury in alfalfa. Thirty percent of the alfalfa cropland in north-central Alberta including the southern Peace River region of Alberta and British Columbia was destroyed during the 1980–1981 winter because of cold soil temperatures, sparse snow cover, and midwinter icing conditions. Many surviving fields experienced reduced vigor in the spring, which is also characteristic of winter injury.

The warm, moist weather conditions stimulated a second flush of growth in the fall. Plants appeared to commence hardening later than normal and the −28°C air temperatures caused soil temperatures to drop to −10°C in late November. This appeared to kill approximately 15% of the alfalfa in the sampled populations, and regrowth and vigor of surviving plants were severely reduced. A mid-December warm spell caused the snow to melt. After this period, fields were covered with ice for the remainder of the winter. No increase in plant mortality was detected until mid-February when the mortality rate increased to 30% in plots sampled at the Research Station. The area affected was bounded by a line from Stettler in the south to Manning in the north, west to Fort St. John, and east to the Alberta–Saskatchewan border.

The importance of leaf frost resistance for alfalfa survival. Alfalfa's ability to survive winter depends in part upon its capacity to synthesize, translocate, and store food reserves in the roots and crowns during the fall. To survive in northern latitudes the plant must synchronize its development sufficiently early in the fall to accumulate food reserves prior to the first killing frost. Although survival does not depend upon overwintering leaves, the cold resistance of the leaves may govern the length of time during which food reserves are translocated to the crown and root in the fall. The objective of this study was to employ controlled freezing facilities in the field to define the influence of frost on the leaves of four alfalfa selections in the fall and on plant survival the following spring.

Plants propagated from single-plant selections of the cultivars Saranac and Luna (*Medicago sativa* L.), Beaver (*M. media* Pers.), and Anik (*M. falcata* L.) were transplanted into the field in May and subjected to a range of freezing temperatures at 3-wk intervals during August and September.

Leaves on all plants had the capacity to harden during the fall, but the selection from Anik was consistently the most frost hardy. In mid-August, a −6°C temperature caused 50% leaf injury in the Anik selection but in late September −12.5°C caused less than 35% injury. Temperatures of −4 to −5°C caused 50% leaf injury to the selections of Beaver, Saranac, and Luna in mid-August whereas in late September temperatures of −9.5 to −10.5°C were required to produce similar amounts of injury. Thus, the Anik selection appeared to start hardening about 3 wk earlier than all other selections.

The potential for injury was very high in the spring as a result of leaf damage in mid-August. This effect diminished as the date of the first fall frost was delayed from early to late September.

Long-term frost records at Beaverlodge, Alta. (55.12°N latitude, 111.16°W longitude) indicate that because of the ability of alfalfa leaves to harden, early fall frosts are not of

sufficient intensity to have a major effect on leaf injury and subsequent winter survival of seedling stands of alfalfa.

Influence of simulated spring frost on barley. Three cultivars of spring barley (*Hordeum vulgare* L.) were planted at four seeding dates to evaluate the effect of a simulated frost at the two-leaf stage on growth and yield. A portable field freezing chamber was used to subject the plants to a −5.6°C stress. The frost caused 49, 64, and 68% injury to the leaves and delayed heading by 2.4, 1.4, and 2.4 days in Galt, Atlas, and Olli, respectively. Frost also reduced the number of tillers per plant, ripe heads per plant, and plants per plot in all cultivars. Although leaves of the late-maturing cultivar Galt showed the most frost resistance, the average 13.8% yield reduction within all three cultivars, caused by the freezing stress, was not significantly different among any of the cultivars. Complete defoliation by clipping resulted in no further reduction in yield beyond that which occurred from partial defoliation by freezing. Delayed seeding resulted in an 8.6% reduction in yield. Frost reduced the yield of early-seeded cultivars by 9.8% and late-seeded cultivars by 17.1%.

Weed control

Effects of soil temperature on the phytotoxicity of trifluralin to wild oats. Experiments were conducted in the field and in controlled environment chambers at Beaverlodge to determine the influence of soil temperature on the phytotoxicity of trifluralin (α,α,α-trifluoro-2,6-dinitro-*N*,*N*-dipropyl-*p*-toluidine) to wild oats (*Avena fatua* L.). In the field, trifluralin reduced emergence of wild oats the most in early May when soil temperatures were lowest. As soil temperatures increased in May, the effectiveness of trifluralin in reducing emergence declined. In controlled environment studies, the effectiveness of trifluralin in reducing shoot growth of wild oats was greatest at 4°C. Trifluralin affected shoot growth less at 7.5°C, but at both 10 and 20°C, small increases in phytotoxicity occurred. When wild oat shoots were exposed to trifluralin vapors at 7.5 and 20°C, shoot growth decreased at 7.5°C but volatilization of trifluralin increased at 20°C. Thus, the lack of any major differences in the effectiveness of trifluralin in reducing wild oat shoot growth at temperatures from 7.5 to 20°C may be because of the counteraction of these two phenomena.

Plant pathology

Fungicidal control of stem eyespot of creeping red fescue. Stem eyespot (*Didymella festucae*) is the most serious disease affecting seed production of creeping red fescue (*Festuca rubra* var. *rubra*) in Canada. Studies on its chemical control have been carried out in vitro and in vivo with good correspondence of results. Disease control was obtained in the field with applications of benomyl, biloxazol, fenarimol, polyoxins B and D, and maneb. However, no yield increases were obtained because seed production was sensitive to the fungicides and doses used. No phytotoxic effects on vegetative growth were observed, nor was 1000-seed weight lower, but number of seeds per head, stem height, and number of heads were reduced. Benomyl consistently gave the most disease control and the greatest yield depression. At rates used, biloxazol appeared to give the best combination of low toxicity and adequate disease control. The most effective spray dates were those associated with high disease pressure resulting from periods of high humidity.

Chemical control of staghead in rapeseed. Metalaxyl applied as a seed dressing followed by a foliar spray or as a foliar spray alone, at the onset of flowering, reduced the number of stagheads whereas when applied as a seed dressing alone it gave no reduction. Reductions produced by seed treatments were not significant, suggesting that the seedborne phase was far less important than external sources of infection.

Winter survival of winter wheat. Snow mold fungicides applied in late fall significantly improved the number of tillers and heads. Despite a relatively mild winter with little surface snow mold activity, five treated plots were significantly better than the control, and all had a higher average tiller count than the control. Surface evidence of snow mold activity is therefore not a reliable indicator of pathogenicity in the crown.

FORAGE CROPS

Nitrogen fixation

Inoculation of alfalfa seed for improved production on moderately acid soils. Currently available methods of inoculating alfalfa

(*Medicago sativa*) seed with *Rhizobium meliloti* were evaluated for their ability to produce effective nodulation and to increase forage yield on a moderately acid (pH 5.8–5.9) soil. Five inoculation treatments were applied in a field experiment: no inoculant; inoculant applied to dry seed at 5.5 g/kg; or inoculant applied to seed at 5.5 g/kg with Nitracoat, at 50.7 g/kg with Pelgel, or at 5.4 g/kg with the Prill-On seed-coating process. Alfalfa yields were not affected when inoculant was applied to the dry seed at 5.5 g/kg. However, yields were increased 46–85% when the inoculant was applied to seed at 50.7 g/kg with a sticking agent. Lower but significant yield increases were obtained from 5.5 g/kg with a sticking agent and from 5.4 g/kg applied with the commercial seed-coating process. In an assay conducted in the greenhouse, strains of *R. meliloti* with double resistance to antibiotics (streptomycin, rifampicin) were used to determine the proportion of nodules formed by the inoculant *Rhizobium*. Between 92 and 100% of the nodules contained antibiotic-resistant strains when the inoculant was applied with a sticking agent or with the seed-coating process, but only 38% of the nodules in the dry treatment contained antibiotic-resistant strains. The results demonstrate the importance of applying high-quality inoculants to the seed with a sticking agent in order to obtain maximum yields of alfalfa on moderately acid soils.

Identification of Canadian strains of Rhizobium meliloti in commercial alfalfa inoculants. The Research Branch of Agriculture Canada has screened, tested, and released *R. meliloti* strains for use in the production of commercial inoculants of alfalfa (*Medicago* spp.) and sweet-clover (*Melilotus* spp.). Quality control of these inoculants requires verification that the mass-produced strains in the inoculant are the same strains as those supplied to the manufacturer. Antisera against vegetative cells of each strain of *R. meliloti* developed in Canada were prepared. Strain specificity was obtained in agglutination tests and with the enzyme-linked immunosorbent assay (ELISA). Using these immunological methods we have demonstrated the presence of the Canadian strains in their respective commercial peat inoculants at viable cell levels of 10^8–10^9 g^{-1}.

The plant infection technique which is now used to evaluate inoculant quality is specific only at the *Rhizobium* species level and requires up to 4 wk for completion. These immunological techniques make it possible to identify strains of *Rhizobium*, and to reduce the time required for testing. The agglutination analysis of inoculants is simple, but requires regrowth of each colony isolate to generate sufficient cell numbers. The ELISA technique is used with colonies picked directly from plate counts and the results are available within 5 days.

PUBLICATIONS

Research

Darwent, A. L.; Bailey, W. G. 1981. Soil moisture and temperature response to shallow tillage in the early spring. Can. J. Soil Sci. 61:455-460.

McKenzie, J. S.; Pankiw, P.; Siemens, B. 1981. Peace alfalfa. Can. J. Plant Sci. 61:473-474.

Murrell, D. C.; Szabo, T. I. 1981. Pollen collection by honey bees at Beaverlodge, Alberta. Am. Bee J. Apicult. Res. 121(12):885-888.

Williams, G. D. V.; McKenzie, J. S.; Sheppard, M. I. 1980. Mesoscale agroclimatic resource mapping by computer, an example for the Peace River region of Canada. Agric. Meteorol. 21:93-109.

Miscellaneous

Elliott, C. R.; Howe, M. 1981. Forage cultivar trials. North. Res. Group Publ. 81-16B. 39 pp.

Fairey, N. A. 1981. Poor quality forages produce manure not meat: South Peace Forage Assn. North. Res. Group Publ. 81-12.

McKenzie, J. S. 1981. Evidence of winter injury in northern Alberta. North. Res. Group Publ. 81-3.

McKenzie, J. S. 1981. Winterkill results in $4 million dollar loss to alfalfa industry. North. Res. Group Publ. 81-8.

McKenzie, J. S. 1981. Why did we have winterkill last year? North. Res. Group Publ. 81-13.

McKenzie, J. S. 1981. Peace—A new winter-hardy alfalfa. North. Res. Group Publ. 81-14.

Nelson, D. L. 1981. Insects that sing. North. Res. Group Publ. 81-6. 5 pp.

Rice, W. A.; Olsen, P. E. 1981. Synergism between effective and ineffective strains of *Rhizobium meliloti*. Page 440 *in* Gibson, A. H.; Newton, W. E., eds. Current perspectives in nitrogen fixation. Australian Academy of Science, Canberra.

Szabo, T. I.; 1981. Queen rearing. North. Res. Group Publ. 81-4.

Szabo, T. I. 1981. Wintering honey bee colonies. North. Res. Group Publ. 81-5.

Szabo, T. I.; Nelson, D. L. 1981. Beekeeping in Western Canada. Agric. Can. Publ. No. 1542.

RESEARCH STATION, BEAVERLODGE, ALTA.

Research Station
Lacombe, Alberta

PROFESSIONAL STAFF

D. E. Waldern, B.S.A., M.S.A., Ph.D.	Director
T. J. Jones	Administrative Officer

Animal Science

J. A. Newman, B.Sc., Dip. An. Gen., Ph.D.	Head of Section; Beef cattle breeding
H. T. Fredeen, B.S.A., M.Sc., Ph.D., F.A.I.C.	Animal breeding
A. P. Sather, B.Sc., M.S., Ph.D.	Swine breeding and management
A. K. W. Tong, B.Sc., M.Sc., Ph.D.	Beef cattle breeding and management, record of performance (ROP)

Meats

A. H. Martin, B.S.A., M.S.A.	Head of Section; Meat science
H. Doornenbal, B.S.A., M.S.A., Ph.D.	Physiology
G. G. Greer, B.Sc., M.Sc., Ph.D.	Microbiology
L. E. Jeremiah, B.S., M.S., Ph.D.	Food technology
A. C. Murray, B.Sc., Ph.D.	Biochemistry

Cereal Breeding, Pathology, and Forage

M. L. Kaufmann, C.D., B.S.A., M.Sc., Ph.D.	Head of Section; Barley breeding
W. B. Berkenkamp, B.S., M.S., Ph.D.	Forage crops, forage pathology
L. J. Piening, B.Sc., M.Sc., Ph.D.	Cereal pathology

Crop Management and Soils

P. A. O'Sullivan, B.Sc., Ph.D.	Head of Section; Weed physiology
C. D. Caldwell, B.Sc., M.Sc., Ph.D.	Crops physiology
S. S. Malhi, B.Sc., M.Sc., Ph.D.	Soil chemistry

Statistics and Data Processing

G. M. Weiss, B.S.A., M.Sc.	Head of Section; Data processing
L. R. Fobert	Computer programming
E. H. Reimer	Systems and programming

Soils and Crops Substation, Vegreville, Alta.

M. R. Carter, B.Sc., M.Sc.	Officer in Charge; Soil fertility and management
J. R. Pearen, B.Sc., B.Ed., M.Sc.	Crop physiology and management

Departures

H. T. Allen, B.Sc., M.Sc. Retired 30 December 1981	Oat breeding
D. A. Dew, B.E. Retired 30 December 1981	Weed biology
D. R. Walker, B.Sc., M.Sc. Deceased 4 August 1981	Soil chemistry

INTRODUCTION

The Lacombe Research Station and the Soils and Crops Substation at Vegreville are responsible for breeding new, high-yielding disease-resistant feed barley and oat varieties, and for developing soil fertility and management, weed control, and cropping systems for coarse cereal, canola, and forage production in the Parklands. Responsibility also exists for regional and national programs in swine and beef cattle breeding; the technical research aspects of record of performance (ROP) beef cattle and swine testing programs; and major carcass evaluation research for national beef and swine carcass grading programs. Meats research is conducted on the physical, chemical, microbiological, and sensory aspects of beef and pork quality.

Several professional staff changes occurred in 1981. Mr. H. T. Allen, Oat breeder, retired after 35 yr of productive service, which included the development of a tomato, an apple, and a potato variety and codevelopment of four oat varieties. Mr. D. A. Dew, Weed biologist, retired after 27 yr service. He recently developed weed distribution maps for Alberta and a weed control spray index for farmers, based on stage of leaf development of barley. We regret to announce the untimely passing of Mr. D. R. Walker, Soils scientist, on 4 August. He will be greatly missed by farmers and co-workers. New professional staff were recruited for Vegreville—Mr. M. R. Carter, Soils scientist and Officer in Charge, and Mr. J. R. Pearen, Crop physiologist; and for Lacombe—Dr. C. D. Caldwell, Crop physiologist, and Dr. S. S. Malhi, Soils scientist.

This report summarizes the highlights of research completed in 1981. For further information please write to the Director, Research Station, Research Branch, Agriculture Canada, Box 1420, Lacombe, Alta. T0C 1S0.

D. E. Waldern
Director

ANIMAL BREEDING

Beef cattle

Breed of sire and environment effects on calving ease, calf mortality, birth weight, and weaning weight of exotic cross calves. Analyses are continuing of results from the foreign cattle breed evaluation project (phase 2), where performance of hybrid females produced by crossing Charolais, Limousin, and Simmental sires with Hereford, Angus, and Shorthorn dams, and their offspring, are being evaluated. It has been found that location differences in calving ease appeared related to the level of precalving stress experienced by the cows. During the first 3 yr of this project, calves born at the Manyberries location (more stressful) weighed 10% of their dams' weights and caused more calving difficulty than Brandon calves, which averaged 8% of the dam's weight. Calves of Limousin sires caused less calving difficulty than those of Charolais, Simmental, or Chianina sires and paired comparisons revealed a ranking of Charolais > Simmental > Limousin for postnatal mortality. In birth weight, Chianina-sired calves exceeded Charolais-sired calves by 2.5%, Simmental-sired calves by 4.2%, and Limousin-sired calves by 11.4%. In preweaning growth rate, Charolais-, Chianina-, and Simmental-sired calves did not differ, but all exceeded Limousin-sired calves by about 6%.

Lifetime productivity of Simmental-, Charolais-, and Limousin-sired hybrid cows in two environments. In research conducted under the Brandon (parkland) and Manyberries (short grass prairie) environments from 1973 to 1979, Simmental-sired cows weaned calves with the highest preweaning growth rate, exceeding calves from Limousin-sired cows by 9% and those from Charolais-sired cows by about 6%. Almost all the exotic cross (or hybrid) cows evaluated weaned faster-growing calves than the more traditional Hereford × Angus. Perhaps the most important comparison was in terms of "lifetime" production (six to eight calf crops) of weaned calf weight. Simmental-sired cows exceeded Charolais- and Limousin-sired cows in production of weight of calf weaned, but they

were inferior to the Charolais-sired cows in conception rate—especially in the less favorable Manyberries environment. The apparent interplay of lactational and environmental stress resulted in Simmental-sired cows exceeding Charolais-sired cows in weaned calf weight per cow exposed to breeding in the favorable Brandon environment (181 versus 176 kg). But in the more stressful Manyberries environment, Charolais-sired cows exceeded the Simmental-sired cows by an almost identical margin (143 versus 139 kg). In similar fashion, cows descended from Shorthorn dams exceeded those from Angus dams in the favorable environment, but in the less favorable environment, the ranking was reversed. All exotic cross hybrids evaluated produced more weaned calf weight per cow exposed to breeding than the widely used Hereford × Angus hybrid, whereas the Charolais-sired and Simmental-sired cows produced 20–25 kg more. Of at least equal importance is the fact that Simmental-sired cows proved superior to Charolais-sired cows only in the favorable environment. In a more stressful environment, Charolais-sired cows were superior.

The effects of initial age and initial weight on the test average daily gain of ROP station-tested bulls. Performance records from 8620 bulls tested during 1969–1980 in 15 Canadian testing stations and representing the Angus, Charolais, Hereford, Limousin, Simmental, and Shorthorn breeds were used to study the possibility that the home (pretest) environment has an influence on the test performance of bulls. The study revealed little effect of initial age on the subsequent average daily gain (ADG) on test, but there was a positive relationship between the initial weight of a bull and his subsequent ADG (partial linear regressions ranged from +0.30 g/day for Charolais to +0.86 g/day for Angus). The bulls' pretest ADG's were estimated by deducting a breed standard birth weight from the initial weight. A low level of phenotypic correlation existed between this pretest ADG and test ADG (r_p = –0.15 to +0.06). The environmental correlations between pretest and on-test ADG were estimated, using average literature values for heritabilities and genetic correlations. The correlations proved significantly negative for all breeds (r_e = –0.62 for Charolais to –0.26 for Simmental). These results support the view that ADG on beef cattle ROP station tests is subject to compensatory growth and is, therefore, affected by pretest environment. This indicates the need for a critical review of beef cattle ROP station testing procedures.

Swine

Effects of penning density and pen group size on the postweaning growth test performance of young boars. A total of 1094 Lacombe boars were performance tested in confinement on solid concrete floors under an ad lib feeding regime. The boars were assigned to group size–penning density treatments that included 1.2 × 2.4 m pens with one or two boars per pen and 2.4 × 2.4 m pens with three to six boars per pen. The penning density, which ranged from 0.96 to 2.88 m^2/boar had no measurable effect upon the average backfat depth, average daily gain, or feed conversion ratio of the test boars. At a constant penning density (1.44 m^2/boar) the number of boars per pen (two versus four) did not influence production traits, nor did singly penned pigs perform differently from those penned in groups. Thus, within the range of management options considered acceptable for swine performance testing (i.e. relatively small group size, low housing density, and rations designed for optimum growth), there was no evidence that the choice of penning system would influence the test results.

MEATS

Pork quality

Lean yield and muscle quality of commercial pigs in Canada. Yield of commercially trimmed (CT), boned (B), and boned–defatted (BDF) pork in relation to weight and backfat thickness was evaluated from a sample of 3807 carcasses obtained from the kill lines of three commercial packing plants located in Alberta, Ontario, and Quebec. Sampling procedures at each plant were designed to provide carcasses from 10 males and 10 females in each cell of a grid defined by 10 weight classes (5-kg intervals ranging from 60 to 100 kg) and 13 fat classes (5-mm intervals ranging from 35 to 90 mm). Fat classes were determined on the basis of the sum of two measurements made at the points of minimum back and maximum loin. Fat class was the primary determinant of yield from the individual lean cuts (ham, loin, picnic, and butt) with yield of CT, B, and

BDF product decreasing as fat class increased. Carcass weight had a negligible influence on yield after fat was considered, and the effects associated with region and sex, although statistically significant, were also negligible. These results indicated that a single regression equation based on fat class would suffice for purposes of yield grading of Canadian hog carcasses. This equation identified a change in percentage yield of the combined lean cuts of 0.89% per fat class (5 mm of fat) with this relationship stable over the carcass weight range of 55–105 kg. Percentage yield of CT product from the total carcass (lean cuts plus belly) was less responsive to changes in total fat (0.50%) because belly yield, both untrimmed and trimmed, increased with increasing fatness.

Sex of carcass had no significant effect on pork quality measurements. There were large regional differences in the incidence of pale, soft, exudative (PSE) and dark, firm, dry (DFD) musculature, and these may have resulted from differences in method of stunning (CO_2 versus electrical) or from differences in preslaughter stress and other management conditions associated with plant of origin. Muscle quality attributes were not associated with grade (i.e. backfat and weight), and multiple regression equations based on several measures of carcass composition explained less than 11% of the variance observed in any of the quality attributes. The frequency of moderate to severely watery longissimus dorsi muscle (PSE score <2.0) ranged from 2.5 to 9.7% depending on plant of origin, with plant differences in the frequency of DFD musculature (scores >3.5) ranging from 21.5 to 34.9%. Muscle temperature and pH taken 45 min postmortem, the measures conventionally employed for early detection of potentially PSE pork, were of negligible utility for this purpose.

Porcine lipid composition. Back and belly fat samples from 60 Lacombe-cross pork carcass sides from three muscle quality groups (PSE, normal, DFD) were utilized to evaluate the influences of muscle quality and anatomical location on fatty acid composition. Backfat samples had lower percentages of palmitic ($C_{16:0}$) and stearic $C_{18:0}$) acids, long ($\geq C_{16}$) and short ($\leq C_{14}$) chain saturated fatty acids and total saturated fatty acids, and higher percentages of oleic ($C_{18:1}$) and linoleic ($C_{18:2}$) acids, polyunsaturated fatty acids, and total unsaturated fatty acids than belly fat samples. Backfat samples also had a wider unsaturated fatty acid to saturated fatty acid ratio than belly fat samples. Carcasses with DFD hams and loins had lower percentages of palmitoleic ($C_{16:1}$) and linoleic ($C_{18:2}$) acids and polyunsaturated fatty acids in their backfat than those with PSE hams and loins. They also had higher ($P < 0.05$) percentages of myristic ($C_{14:0}$) and stearic ($C_{18:0}$) acids and long chain saturated fatty acids ($\geq C_{16}$), and lower percentages ($P < 0.05$) of palmitic ($C_{16:0}$) and palmitoleic ($C_{16:1}$) acids in their backfat than carcasses with normal hams and loins. Moreover, they had lower ($P < 0.05$) percentages of palmitoleic ($C_{16:1}$) and linoleic ($C_{18:2}$) acids and polyunsaturated fatty acids in their belly fat than carcasses with normal and PSE hams and loins. The fact that the lipid composition of carcasses differed significantly among muscle quality groups is important, because it implies that factors (stress) producing differences in muscle quality may also significantly influence the fatty acid composition, and thereby, the physical properties of carcass lipids.

Retail preservation of beef

Mechanism of beef shelf life extension by sorbate. Sorbic acid and its potassium salt have been included with those compounds "generally recognized as safe" (GRAS) by the U.S. Food and Drug Administration, and are currently utilized as preservatives in a variety of foods. Since there was no evidence demonstrating the effect of sorbates on the quality of fresh, red meats, studies at Lacombe were conducted to document the influence of sorbate on the growth of beef spoilage bacteria and the shelf life of retail steaks. The addition of potassium sorbate to beef extract medium affected the growth of a beef spoilage pseudomonad by producing a dose-dependent increase in the length of the lag phase of growth without altering the exponential growth rate. Similarly, the lag phase of bacterial growth on steaks dipped in 10% potassium sorbate was significantly extended from 0.44 day (control) to 3.95 days. However, following this initial delay, no significant differences could be determined in the rate of bacterial growth on sorbate-dipped steaks when compared with untreated, control samples. These findings demonstrate that potassium sorbate acts, both in beef extract medium and on steaks, by prolonging the lag

phase of bacterial growth without affecting the subsequent rate of growth. Consequently, the bacterial load on sorbate-dipped steaks was reduced and steak retail shelf life increased from 2 to 4 days.

PLANT BREEDING, FORAGE CROPS, AND PLANT PATHOLOGY

Forage diseases

Winter crown rot of alfalfa. Alfalfa yield losses caused by winter crown rot were evaluated in a 5-yr study following the year of stand establishment. The test consisted of four treatments: an unsprayed check of Beaver alfalfa (*Medicago sativa*); Beaver alfalfa sprayed with mercuric chloride each fall; Beaver alfalfa sprayed with borax each fall; and an unsprayed crown rot resistant line of *M. falcata*. Crown rot was significantly reduced by fall spray treatments, with the result that the average forage dry matter yields over 5 yr were untreated Beaver, 6100 kg/ha; mercuric chloride treated Beaver, 6800 kg/ha; borax treated Beaver, 6500 kg/ha; and *M. falcata*, 6100 kg/ha. The advantage of crown rot resistance of *M. falcata*, a line with a yield potential lower than Beaver, was demonstrated when forage yield of the resistant cultivar equaled that of untreated Beaver.

CROP MANAGEMENT AND SOILS

Soil fertility

Soil and fertilizer potassium in Alberta. From summaries of soil test results we estimate that approximately 400 000 ha of cropped land in Alberta are deficient in potassium (K). A critical soil level of K for cereals in central Alberta was established at 220 kg/ha. The application of K at 17–34 kg/ha drilled with the seed of cereal crops was found adequate in correcting K deficiency on most soils. Under dry soil conditions, at rates of 30 kg/ha or higher, K should be banded away from the seed to avoid germination damage. In field experiments, use of potassium fertilizer in deficient soils increased barley yields by an average of 13%.

Differential absorption of micro and macro elements in barley cultivars. Analyses of five barley cultivars (Bonanza, Centennial, Conquest, Galt, and Gateway) for content of potassium (K), sodium (Na), calcium (Ca), magnesium (Mg), iron (Fe), manganese (Mn), copper (Cu), and zinc (Zn) indicated that there are differences between cultivars in their ability to absorb some of these mineral elements. The differences were smaller in mature barley grain than for whole aboveground portions of barley plants harvested between heading and flowering. Gateway had the highest total contents of micro and macro elements, both in grain and in whole plants, and Centennial (with the exception of total macro elements content in mature grain) had the lowest contents of micro and macro elements. The micro element contents of both whole plant material and of mature grain were influenced by soil pH. In whole plant material, Mn decreased with increasing soil pH, whereas Cu increased as soil pH increased. In grain, Fe, Mn, and Zn contents significantly decreased with increasing soil pH, but Cu was not affected.

Deposition of sulfur (S) gases from multiple-scattered sources in Alberta. Various measurements utilizing soils, plants, precipitation, and free water surfaces indicate that approximately 7–9 kg/ha of sulfate was deposited annually within an area of 4600 km^2. This area contained or had adjacent to its boundaries 10 emission sources of S for which the provincial government had established a combined allowable daily emission of approximately 330 t of S. At distances of 40 km or more from the emission sources the annual deposition rate of S had declined to 4–6 kg/ha.

Weed research

Selective control of Canada thistle in rapeseed. The herbicide 3,6-dichloropicolinic acid when applied at 0.2–0.3 kg/ha resulted in excellent control of Canada thistle topgrowth and regrowth in rapeseed, with no adverse effects to the rapeseed. Rapeseed yields were increased over untreated checks at 12 of 17 locations by an average of 64%.

Estimating yield loss of barley caused by Canada thistle competition. Correlation coefficients between barley yields and total numbers of Canada thistle shoots per square metre, numbers of shoots taller than 0.5 m/m^2, numbers of flowering shoots per square metre, or shoot dry weight in grams per square metre, using two representations of the density data (untransformed or square root transformation) were significant at $P < 0.01$. The data for percentage yield loss of barley

and total numbers of Canada thistle shoots per square metre were analyzed by regression, using both representations of the data, and yielded the following equations:

[1] $\hat{y} = 14.03 + 0.85X$

[2] $\hat{y} = 0.42 + 7.6\sqrt{x}$

where $\hat{y}$ = estimated percentage yield loss of barley, X = the total number of Canada thistle shoots per square metre, and 0.85 and 7.6 are the indices of competition for equations [1] and [2], respectively. Comparing a Canada thistle shoot with a wild oat plant in barley, Canada thistle may be about 3.4 times as competitive as wild oats.

SOILS AND CROPS SUBSTATION VEGREVILLE

Soil research

Deep plowing of a Brown Solodized Solonetz soil under irrigation. A study was initiated to determine the effect of deep plowing on the productivity and chemistry of an irrigated Brown Solodized Solonetz soil that had a Ca-enriched Csk horizon at the 45- to 75-cm depth. Deep plowing provided an average 30% increase in the yield of the bromegrass–alfalfa hay crop mixture during the 4-yr study period. Furthermore, the chemistry of the Bnt horizon was improved, as indicated by a significant widening of the extractable Ca-to-Na ratio. These results suggest that deep plowing may be a possible reclamation procedure for Solonetzic soils in irrigated areas.

Transformation of a Solonetz soil to a Solod soil by fertilization. Changes in soil chemical and physical properties of a Black Solonetz soil were assessed 9 yr after the discontinuance of 10 yr of annual applications of ammonium–phosphate–sulfate. In general, the changes that accompany the transformation of a Solonetz soil to a Solod soil were observed in the Ap and upper Bnt horizons. Thus, fertilization not only substantially increased crop production, but also enhanced the formation of a potentially productive soil. The use of calcium nitrate in place of the ammonium source of N prevented the harmful increase in soil acidity associated with the latter.

Changes in Solonetzic soil properties by deep plowing and ripping. Comparisons between deep plowing (mixing the A, B, and C horizons) and soil ripping, to a depth of 60 cm, were conducted at four sites on a Brown Solonetzic soil. A resultant desirable extractable Ca-to-Na ratio, approximately 4:1, proved to be the main factor involved in the beneficial changes derived from horizon mixing and for determining the depth of plowing required.

Ripping proved to be unsuccessful under conditions of high exchangeable N, clay texture, and deep Bnt horizons.

PUBLICATIONS

Research

Cairns, R. R.; Peters, T. W.; Lavado, R. 1981. The effect of deep plowing and fertilization on the properties of three natriborolls and crop yield in Alberta, Canada. [In Spanish.] Rev. Fac. Agron. 2(2):59-64.

Doornenbal, H.; Tong, A. K. W. 1981. Growth, development and chemical composition of the pig. IV. Relative growth of visceral organs. Growth 45:279-285.

Fredeen, H. T.; Weiss, G. M. 1981. Comparison of techniques for evaluating lean content of hog carcasses. Can. J. Anim. Sci. 61:319-333.

Fredeen, H. T.; Weiss, G. M.; Lawson, J. E.; Newman, J. A.; Rahnefeld, G. W. 1981. Lifetime reproductive efficency of first-cross beef cows under contrasting environments. Can. J. Anim. Sci. 61:539-554.

Fredeen, H. T.; Weiss, G. M.; Rahnefeld, G. W.; Lawson, J. E.; Newman, J. A. 1981. Growth patterns of cows under two environments. Can. J. Anim. Sci. 61:243-259.

Greer, G. G. 1981. Improved acceptance of retail beef through proper temperature control. Dairy Food Sanit. 1:460.

Greer, G. G. 1981. Rapid detection of psychrotrophic bacteria in relation to beef quality. J. Food Sci. 46:1669-1672.

Greer, G. G.; Jeremiah, L. E. 1981. Proper control of retail case temperature improves beef shelf life. J. Food Prot. 44:297-299.

Hawn, E. J.; Berkenkamp, W. B.; Lebeau, J. B. 1981. Evaluation of losses in alfalfa hay production caused by crown rot. Can. J. Plant Pathol. 3(2):103-105.

Jeremiah, L. E.; Martin, A. H. 1981. Intramuscular collagen content and solubility: Their relationship to tenderness and alteration by postmortem aging. Can. J. Anim. Sci. 61:53-61.

Karkanis, P. G.; Cairns, R. R. 1981. Some effects of deep plowing and fertilizing a Solonetzic soil under irrigation. Can. J. Soil Sci. 61:157-160.

Martin, A. H. 1981. Electrically stimulated meat. Can. Home Econ. J. 31:202-206.

Martin, A. H.; Fredeen, H. T.; L'Hirondelle, P. J.; Murray, A. C.; Weiss, G. M. 1981. Pork quality attributes, their estimation and their relationship with carcass composition in commercial pigs. Can. J. Anim. Sci. 61:289-298.

Martin, A. H.; Fredeen, H. T.; Weiss, G. M.; Fortin, A.; Sim, D. W. 1981. Yield of trimmed product from hog carcasses in relation to carcass weight and backfat. Can. J. Anim. Sci. 61:299-318.

O'Sullivan, P. A. 1981. Control of *Avena fatua* and *Fagopyrum tataricum* with tank mixtures of linuron or linuron + MCPA and sequential applications of linuron and post-emergence *A. fatua* herbicides. Weed Res. 21:211-217.

O'Sullivan, P. A. 1981. Control of wild oats, green foxtail and Tartary buckwheat with mixtures of propanil or propanil/MCPA and postemergence wild oat herbicides. Can. J. Plant Sci. 61:383-390.

O'Sullivan, P. A.; O'Donovan, J. T.; Hamman, W. M. 1981. Influence of non-ionic surfactants, ammonium sulphate, water quality and spray volume on the phytotoxicity of glyphosate. Can. J. Plant Sci. 61:391-400.

Tong, A. K. W.; Newman, J. A.; Martin, A. H.; Fredeen, H. T. 1981. Live animal ultrasonic measurements of subcutaneous fat thickness as predictors of beef carcass composition. Can. J. Anim. Sci. 61:483-491.

Walker, D. R.; Dick, A. C.; Nyborg, M. 1981. Deposition of sulphur gases from multiple scattered sources in Alberta. Water Air Soil Pollut. 16:223-231.

Miscellaneous

Corlett, M.; Egger, K. N.; Berkenkamp, W. B. 1981. *Pleospora herbarum*. Fungi Can. No. 232.

Corlett, M.; Egger, K. N.; Berkenkamp, W. B. 1981. *Stemphylium sarciniforme*. Fungi Can. No. 233.

Greer, G. G.; Jeremiah, L. E. 1981. Effect of sanitation and temperature on retail beef spoilage. Can. Agric. 26(2):29-30.

Jeremiah, L. E.; Martin, A. H. 1981. Effect of electrical stimulation upon the palatability, consumer acceptance, retail acceptability, and case-life of beef. Can. Agric. 26(3):23.

O'Sullivan, P. A. 1981. Registered tank mixtures of herbicides for the major crops in Western Canada. 1981. Canadex 641.

Research Station
Lethbridge, Alberta

PROFESSIONAL STAFF

W. N. MacNaughton,[1] B.Sc., M.Sc., Ph.D.	Director
D. B. Wilson, B.Sc., M.S., Ph.D.	Acting Director
T. G. Atkinson, B.S.A., M.Sc., Ph.D.	Assistant Director
S. B. Arnason, B.S.A.	Head, Administration
C. G. Schoening	Finance Officer
M. J. McCormick	Personnel Officer

Scientific Support

G. K. Honey, B.S.A.	Technical Information Officer
G. C. Kozub, B.Sc., M.Sc.	Statistician
K. K. Krogman, B.Sc., M.Sc.	Acting Scientific Editor
J. P. Miska,[2] B.A., B.L.S.	Library Area Coordinator
C. M. Ronning Mains,[2] B.A., B.L.S.	Librarian
G. B. Schaalje, B.S., M.S.	Statistician

Animal Parasitology

W. O. Haufe, B.A., M.Sc., D.I.C., Ph.D.	Head of Section; Bioclimatology
R. W. Baron, B.Sc., Ph.D.	Immunology
M. A. Khan, G.V.Sc., M.S., Ph.D.	Toxicology
W. A. Nelson, B.Sc., M.Sc., Ph.D.	Parasitology
R. H. Robertson, B.A., M.Sc.	Serology
J. A. Shemanchuk, C.D., B.Sc., M.Sc.	Biting-fly ecology
J. L. Shipp, B.Sc., M.Sc., Ph.D.	Black fly ecology
W. G. Taylor, B.S.P., Ph.D.	Pesticide chemistry
J. Weintraub, B.A., M.S.	Cattle grub ecology
P. R. Wilkinson, B.A., M.A., Ph.D.	Tick ecology and control

Animal Science

E. E. Swierstra, B.S.A., M.S.A., Ph.D.	Head of Section; Reproductive physiology

C. B. M. Bailey, B.S.A., M.S.A., Ph.D.	Animal physiology
K.-J. Cheng, B.Sc., M.Sc., Ph.D.	Rumen microbiology
G. H. Coultfr, B.Sc., Ph.D.	Reproductive physiology
G. A. Grigat, B.Sc., Ph.D.	Animal nutrition
R. Hironaka, B.Sc., M.Sc., Ph.D.	Animal nutrition
J. E. Lawson, B.S.A., M.S.A.	Beef cattle breeding
G. J. Mears, B.Sc., M.Sc., Ph.D.	Animal physiology
J. A. P. Vesely, B.S.A., M.S.A., Ph.D.	Sheep and dairy cattle breeding

Crop Entomology

S. McDonald, C.D., B.Sc., M.Sc.	Head of Section; Toxicology
J. R. Byers, B.S.A., M.Sc., Ph.D.	Cutworm ecology
W. A. Charnetski, B.Sc., M.Sc., Ph.D.	Insecticides
J. M. Hardman, B.Sc., M.Sc., D.I.C., Ph.D.	Grasshoppers
A. M. Harper, B.Sc., M.Sc., Ph.D.	Aphids
B. D. Hill, B.Sc., M.Sc., Ph.D.	Residue chemistry
K. W. Richards, B.Sc., M.Sc., Ph.D.	Insect pollinators
B. D. Schaber, B.Sc., M.Sc., Ph.D.	Forage crop pests
D. L. Struble, B.A., M.A., Ph.D.	Insect attractants

Plant Pathology

D. W. A. Roberts, B.A., Ph.D.	Acting Head of Section; Coldhardiness physiology
K. J. Degenhardt, B.Sc., M.Sc., Ph.D.	Smuts and oilseed diseases
F. R. Harper, B.Sc., M.Sc., Ph.D	Cereal leaf diseases
H.-C. Huang, B.Sc., M.Sc., Ph.D	Forage and specialty crops pathology
G. A. Nelson, B.Sc., M.Sc., Ph.D.	Potato and bacterial diseases

Plant Science

S. Smoliak, F.S.R.M., B.Sc., M.S.	Acting Head of Section; Dryland pastures
J. R. Allan, B.Sc., M.A., Ph.D.	Aquatic plant physiology
M. R. Hanna, B.S.A., M.S.A., Ph.D.	Forage legume breeding
M. S. Kaldy, B.Sc., M.S., Ph.D.	Food science
G. A. Kemp, B.Sc., Ph.D.	Vegetable breeding
D. R. Lynch, B.Sc., M.Sc., Ph.D.	Potato breeding
M. D. MacDonald, B.Sc., Ph.D.	Corn breeding
W. H. Mains, B.Sc.Eng.	Forage systems engineering
D. J. Major, B.Sc. (Agr.), M.Sc., Ph.D.	Crop physiology
K. W. May, B.Sc. (Agr.), M.Sc., Ph.D.	Barley breeding
R. J. Morrison, B.Sc. (Agr.), Ph.D.	Spring wheat breeding
J. R. Moyer, B.Sc., M.Sc., Ph.D.	Weed control
H.-H. Muendel, B.S.A., M.S., Ph.D.	New crops
J. B. Thomas, B.Sc., M.Sc., Ph.D.	Winter and soft white spring wheat breeding

E. D. P. WHELAN, B.S.A., M.S.A., Ph.D.	Wheat cytogenetics

Soil Science

D. C. MACKAY, B.Sc., M.S., Ph.D.	Head of Section; Plant nutrition
R. W. BARENDREGT, B.Sc., M.Sc., Ph.D.	Irrigation engineering
G. J. BEKE, B.S.A., M.Sc., Ph.D.	Hydrology
J. B. BOLE,[3] B.S.A., M.Sc., Ph.D.	Plant nutrition
J. M. CAREFOOT, B.S.A., M.S.A.	Chemical analyses
C. CHANG, B.Sc., M.Sc., Ph.D.	Soil physics
J. F. DORMAAR,[4] B.S.A., M.S.A., Ph.D.	Organic matter
S. DUBETZ, B.Sc., M.S.	Irrigation agronomy
S. FREYMAN, B.Sc., M.S.A., Ph.D.	Dryland agronomy
W. D. GOULD, B.Sc., M.Sc., Ph.D.	Soil denitrification
E. H. HOBBS, B.Sc.Eng.	Irrigation engineering
R. M. N. KUCEY, B.Sc., Ph.D.	Soil fertility
C. W. LINDWALL,[5] B.Sc., M.Sc.	Agricultural engineering
R. G. L. MCCREADY, B.Sc., M.Sc., Ph.D.	Biophysical chemistry
R. J. RENNIE, B.S.A., M.Sc., Ph.D.	Nitrogen fixation
T. G. SOMMERFELDT, B.Sc., M.S., Ph.D.	Drainage engineering

Departures

J. E. ANDREWS, F.A.I.C., B.S.A., M.S., Ph.D. Transferred to Western Regional Headquarters, Saskatoon, Sask., 1 October 1981	Director
G. C. R. CROOME, B.A., M.Sc.F. Resigned 7 August 1981	Scientific Editor
T. D. CARRUTHERS, D.V.M., Ph.D. Resigned 29 December 1981	Reproductive physiology
M. N. GRANT, B.Sc., M.Sc., Ph.D. Retired 14 August 1981	Winter wheat breeding
K. K. KLEIN,[6] B.S.A., M.Sc., Ph.D. Resigned 29 December 1981	Head of Section; Economics
C. E. LILLY, B.Sc., M.Sc. Retired 30 December 1981	Potato and sugar beet pests
C. J. PALMER, B.S., Ph.D. Resigned 25 September 1981	Physical chemistry
K. D. RUSSELL,[6] B.Sc., M.S., Ph.D. Resigned 31 July 1981	Irrigated crop production
M. P. SHARMA, B.Sc., M.Sc., Ph.D. Resigned 15 August 1981	
J. A. TRAQUAIR, B.Sc., Ph.D. Transferred to Agriculture Canada Research Station, Harrow, Ont., 28 August 1981	Forage and low-temperature diseases
R. P. ZENTNER,[6] B.S.A., M.Sc., Ph.D. Transferred to Agriculture Canada Research Station, Swift Current, Sask., September 1981	Dryland crop production

VISITING SCIENTISTS

J. R. DE FREITAS, B.Sc. — Soil microbiology
Centro de Energia Nuclear na Agricultura, Piracicaba, Brazil, on IAEA training fellowship, June to December 1981 .

H. KUDO, D.V.M., M.V.S., Ph.D. — Rumen microbiology
Postdoctorate fellow, September 1981 to September 1983

R. G. HOLMBERG, Ph.D. — Grasshoppers
Athabasca University, on sabbatical leave August 1980 to August 1981

---

[1]Seconded to Western Regional Headquarters, Saskatoon, Sask.
[2]Seconded from Libraries Division, Finance and Administration Branch.
[3]On leave of absence to International Atomic Energy Agency, Vienna, Austria, January 1980 to June 1982.
[4]On transfer of work to the Institut fuer Pflanzenernaehrung und Bodenkunde (FAL), Braunschweig, West Germany, March 1981 to March 1982.
[5]On educational leave, Iowa State University, Ames, Iowa, August 1980 to August 1983.
[6]Formerly seconded from the Regional Development and International Affairs Branch, Agriculture Canada.

INTRODUCTION

The Research Station at Lethbridge celebrated its 75th anniversary in 1981. Established in 1906, the Lethbridge Station has grown to be the largest in the Research Branch, with 70 scientists in six discipline-oriented sections conducting interdisciplinary research that contributes to 13 Branch subobjectives. The results of these studies contribute to the continuing success and intensification of agricultural production in southern Alberta as well as having significant impact on regional and national agricultural priorities.

The brief reports that follow highlight some of the achievements in 1981 and outline progress in ongoing applied and basic research. In this 75th year of our establishment, analyses of data from a dryland crop rotation begun in 1912 and an irrigated crop rotation begun in 1915 have yielded significant results. The dryland rotation showed that wheat yields increased by 25% during the past 18 yr, mostly because of more effective weed control with herbicides and consequently less need for cultivation and less loss of soil moisture. In the irrigated rotation, during two-thirds of a century of intensive cropping, soil nitrogen and phosphorus levels were maintained along with very high crop yields, with only moderate amounts of fertilization.

Encouraging progress continues to be made in the application of basic research to solve agricultural problems. This is particularly true in the control of insect pests of plants and animals where integrated pest management systems or components of such systems are being evaluated. As a result of our pioneering success in demonstrating the effectiveness of the sterile male technique to eradicate the cattle grub, a major cooperative project with the United States Department of Agriculture has been initiated. Progress in understanding other basic phenomena, including those that control animal and plant growth and development, crop productivity, and the rise and fall of pest populations, is laying the foundation for improvements in agricultural efficiency.

There were several significant changes in professional staff during the year. Dr. J. E. Andrews, Director since 1969, was appointed Director General of the Western Region of the Research Branch with headquarters in Saskatoon, Sask. He was succeeded by Dr. W. N. MacNaughton, who was immediately seconded to Regional Headquarters as Acting Associate Director General. Dr. D. B. Wilson was subsequently appointed Acting Director. The Economics Unit was lost with the reassignment of the three seconded positions by the Regional Development and International Affairs Branch. Several scientific staff were lost through transfers, resignations, or retirements during the year and some new appointments were made. Those retiring after long and successful careers at the Lethbridge Station were Dr. M. N. Grant, winter wheat breeder, and Mr. C. E. Lilly, entomologist.

This report summarizes some of the main research results of 1981. Further detailed information may be obtained from the scientists or from their publications listed at the end of the report. Correspondence or requests for reprints should be addressed to the Research Station, Agriculture Canada, Lethbridge, Alta. T1J 4B1.

D. B. Wilson
Acting Director

ANIMAL PARASITOLOGY

Survey of *Simulium arcticum* in southern Alberta

A survey to establish the geographic distribution of the black fly, *Simulium arcticum* Malloch, was conducted in southern Alberta to determine whether this pest represents a problem for the cattle industry in the south and to find possible sites for studies on the biology of this species. Twenty-four waterways were surveyed in an area encompassing approximately 68 000 km^2. The larval and pupal stages of black flies were collected by placing ropes in the water and searching rocks and submerged vegetation.

S. arcticum specimens were collected from 19 waterways, with the majority found in Beaver Mines Creek and the Oldman, Crowsnest, St. Mary, Belly, Milk, and Bow

rivers. Thus, *S. arcticum* can be abundant from prairie regions (815-m elevation) to mountainous areas (1387 m). Turbidity, water velocity, pH, water depth, and water temperature were recorded at each collection site but none of these physical parameters appeared to influence the abundance of *S. arcticum* at the various sites.

Cattle warble grubs

Eradication of cattle grubs. The cooperating cattle ranch, which previously was reported to have eradicated the common cattle grub, *Hypoderma lineatum*, by combined application of systemic insecticides and sterile fly releases, was free from this species for the 4th yr consecutively. Releases have been terminated on the ranch but initiated on neighboring ranches to enlarge the area of eradication.

After releases of sterile flies of the northern cattle grub (*H. bovis*) for 2 yr in succession, that species has been reduced to 0.03 grub per animal both in treated cattle on the ranch and in samples of untreated cattle brought to the laboratory. By contrast, cattle on some adjacent ranches showed substantial grub population increases of this species, reaching 8.7 grubs per animal on one ranch. Possibly, invasion of *H. bovis* flies from neighboring ranches and insufficient populations of sterile flies prevented complete eradication.

A Canada–USA cooperative pilot project was initiated to evaluate the sterile insect technique for cattle grubs in a 2500 km^2 area astride the Alberta–Montana border. The objectives are to determine whether sterile warble fly releases integrated with systemic insecticide treatments can eliminate the grubs on a larger scale, about 12 times the size of the cooperating ranch, and to measure the benefits and economic gains that would accrue to the producer, feeder, processor, and consumer related to the reduced numbers of cattle grubs. Initial assessment of cattle grub populations is scheduled for the spring of 1982.

Host resistance to warble grubs in cattle. The feasibility of vaccinating calves against warbles with a crude larval grub extract or metabolic antigen derived from the in vitro culture of cattle grubs was investigated. Calves vaccinated with the crude larval extract produced 63.9% fewer viable *H. lineatum* grubs and 67.4% fewer *H. bovis* grubs than their respective controls. However, animals treated with metabolic antigen produced similar numbers of *H. lineatum* as controls, but numbers of *H. bovis* were reduced by 31.6%. These results confirm the hypothesis that resistance to cattle grub infestations has an immunological basis and that vaccination is a feasible approach to grub control. It is expected that investigations into antigenic composition and dosage levels will improve effectiveness of the vaccine.

In vitro bioassays of antibodies from grub-resistant cattle produced 91.7% mortality of first-instar larvae of *H. lineatum*. These bioassays further indicate that the circulating antibodies, which are produced in cattle in response to larval activities within the host, have an immune function.

Chemical control of cattle grubs. Whether applied by the spot-on or pour-on method, Spotton, a formulation of fenthion, was 99.6% effective for systemic control of cattle grubs. Weight gains improved in steers treated by either method as compared with their untreated controls infested with 44 grubs per head. Steers treated by the spot-on and pour-on methods showed gains of 3 and 2%, respectively, during the posttreatment period of 191 days.

Biological control of manure-breeding flies

Colonies of *Muscidifurax raptor* and *Spalangia endius*, pteromalid parasites of muscoid puparia, were established in the laboratory from imported stocks to produce an excess of 50 000 parasites weekly. Parasite development, survival, and management techniques were worked out for use in integrated pest management (IPM) of house flies.

IPM was initiated in response to a pig farmer's urgent requests, using *M. raptor* in combination with the farmer's insecticidal bait treatment in the weanling pig barn. This barn is maintained at more than 25°C winter and summer and produces house flies year round. Continued use of insecticide baits and periodic fogging with pyrethroids had not effectively controlled the house fly population. About 15 000–40 000 specimens of *M. raptor* were distributed in the piggery every 2nd wk and house fly counts taken. After three parasite releases, the fly counts were reduced by 63%; after five releases, 92% control was obtained. After achieving 98% reduction of house flies, parasite releases were discontinued and fly counts have remained at those low levels to the present. Current observations are

concerned with the level of fly control obtainable by the residual parasite populations. Further parasite releases may be reinstituted in an attempt to eradicate the flies during the winter before outside flies can invade the premises.

Ecology and control of ticks causing paralysis of cattle

In April, average numbers of attached female Rocky Mountain wood ticks (RMWT) on Jersey, Hereford, Holstein, and Angus yearlings in a tick-infested 129-ha field in British Columbia were 47.8, 63.7, 86.1, and 91.8, respectively. A higher proportion of the total ticks were on the heads of the dairy breeds compared with the distribution on the beef breeds. All breeds tested to date have been susceptible to some tick attachment and to tick paralysis.

Tests with adult RMWT placed on groups of cattle treated 5 wk previously with 1% deltamethrin or 1% permethrin pour-ons showed complete kill with deltamethrin and reduced feeding with permethrin compared with an untreated group. Protection lasting 5 wk would be more than adequate to cover the season of danger from cattle paralysis.

Chemical control

Horn flies. Bovaid (Shell) and Rabon (Diamond Shamrock) ear tags, applied in the 1st wk of July to yearlings maintained on irrigated pastures, were 99 and 95% effective, respectively, for control of horn flies for the balance of the fly season. However, the protection from horn flies did not result in improved weight gains in the tagged steers during the grazing season.

Synthetic pyrethroid insecticides. A research contract was completed on the isolation of four isomers of 3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid, a pyrethroid acid. These isomeric acids represent key intermediates for obtaining pure chlorine-containing synthetic pyrethroid insecticides, which are currently registered as isomeric mixtures. By esterification of these acids with *m*-phenoxybenzyl alcohol, the four optical isomers of permethrin were synthesized in this laboratory. Three of the four isomers were isolated in high optical and chemical purity. In laboratory bioassay tests with mosquitoes, it was found that larvicidal activity was primarily associated with two (1R,*cis* and 1R,*trans*) isomers of permethrin.

A related pyrethroid acid, 5,5-dichloro-5-pentanoic acid, was synthesized and characterized for use in clarifying the complex relationships between structure and activity in this group of insecticides.

Host resistance to sheep ked

Mortality of the sheep ked not caused by host resistance was originally thought to be due to *Trypanosoma melophagium* (Flu). The cause is now shown to be breakdown of the midgut wall through hypoxia caused by debris-plugged spiracles. This confirms that *T. melophagium* is nonpathogenic for the ked.

ANIMAL SCIENCE

Beef cattle

Protein requirements of beef cattle. The protein requirements of beef cattle were calculated as the sum of four components: growth protein, endogenous urinary protein, hair and scurf protein, and metabolic fecal protein. To determine the total dietary protein requirement, total protein was adjusted for biological value (the percentage of digested protein utilized by the animal) and the digestibility of the protein consumed. The biological value of protein in the diet was determined from digestibility trials to be 65%. Also, we found that protein digestibility is related to dry matter digestibility, which was included in our calculations. Several factors, including dry matter digestibility of the diet, rate of gain, and weight of cattle, influence dietary protein requirement. Our estimates of percentage protein required in the diet are higher for lightweight calves but lower for feeder cattle approaching slaughter weight than the National Research Council estimates.

Rumen microbiology. Examination of particulate feed digested in vivo in the rumen, and of the leaves of specific legumes digested in vitro by a mixed population of rumen bacteria, showed that very extensive glycocalyx-enclosed bacterial microcolonies developed on many of the available surfaces. In some instances the surface was almost exclusively colonized by one type of bacteria, and in other cases two or more specific types colonized the surface to form a distinct consortium. Electron microscopy revealed the true extent of the glycocalyx of the adherent bacteria. In cases where the fibers of the

glycocalyx were stabilized by their attachment at multiple points to solid surfaces, the glycocalyx occupied more space than the bacteria themselves. It is suggested that bacterial glycocalyx mediates the formation of microcolonies, which constitute the predominant mode of growth in the rumen bacterial ecosystem, as well as the adhesion of bacteria to the plant tissue to facilitate digestion.

Microbial degradation of aliphatic nitrotoxin. Nitropropionic acid (NPA) and nitropropanol (NPOH) are forage constituents that can be toxic to ruminants and nonruminants. Of 33 pure strains of rumen bacteria from the Lethbridge collection, five degraded NPOH and NPA under anaerobic conditions and another five degraded only NPA. The NPA was metabolized at a faster rate than the NPOH by pure cultures of rumen bacteria and by mixed rumen microorganisms. Nitrite was detected during incubation of NPOH and of NPA with resting cells but not with growing cultures of active strains of rumen bacteria. Nitrite was metabolized much faster than the nitrotoxins by pure cultures of rumen bacteria and by mixed rumen microoganisms. The results suggest the nitro half of NPA or NPOH is metabolized to inorganic nitrite and the nitrite is reduced to ammonia by rumen microorganisms, thereby resulting in its detoxification.

Dairy cattle

Dairy cattle management. Findings of a long-term dairy cattle breeding project emphasized once again the importance of good management to increase milk production and to reduce culling rate. These two traits were studied in three Holstein and three Ayrshire herds that were genetically similar because the same bulls had been used by means of artificial insemination over a 25-yr period immediately preceding this study. Management among the herds differed. Milk production of the Holstein herds ranged from 5043 to 7849 kg and of the Ayrshire herds from 3922 to 4294 kg per lactation (308-day mature equivalent). Culling rates due to infertility varied from 15 to 29% for the Holstein herds and from 5 to 31% for the Ayrshire herds.

Sheep

Light control to increase lamb production. Six consecutive production cycles, each lasting 240 days (from the start of breeding in one cycle to the start of breeding in the next), were completed with half-Finnish Landrace and half-Dorset ewes. For each cross, group A was maintained under natural light and exposed to rams once a year in fall. Group B was also maintained under natural light but exposed to rams every 8 mo. Ewes in group C were also exposed to rams every 8 mo but maintained under an artificial light regime. The half-Finnish ewes and half-Dorset ewes in group A produced annually 216 and 181 lambs per 100 ewes exposed to rams. Corresponding values for group B were 209 and 165, and for group C, 278 and 196.

Microbial inoculation of newborn lambs. Newborn lambs reared in an enclosure without maternal contact had a greater rate of weight gain when inoculated with a mixture of microorganisms isolated from the ruminant digestive tract than when not inoculated. All 12 lambs in this study maintained good general health, and very little diarrhea was detected at any time during the experiment. All the lambs were weighed at slaughter (120 days), and the inoculated group had gained 23% (6.1 kg) more than the control group. The empty digestive tracts of the inoculated group weighed 25% (0.5 kg) more than those of the control group. The inoculated group showed higher microbial activity in the rumen in that both total bacterial count and fermentation rate were elevated.

Growth hormone in fetal lambs. Whether or not growth hormone (GH) has a role in controlling the rate at which an animal achieves its final body weight is unknown despite many attempts to characterize such a role. During late pregnancy in sheep, when the fetus is growing rapidly, fetal plasma GH levels are 10- to 20-fold higher than those of the mother, which could account for this rapid growth. To examine the possibility that there is a relationship between circulating GH levels and fetal growth rate, 11 sheep fetuses were fitted with chronic, indwelling-saphenous vein cannulas at 110 days of gestation, and fetal blood samples for the measurement of GH were obtained from 115 days of gestation until birth. Fetal plasma GH concentrations averaged 120 ng/mL (10 times maternal levels) from 116 to 124 days of

gestation and increased to 149 ng/mL by the last week of pregnancy. A significant ($P < 0.05$) negative correlation was found between fetal plasma GH concentration and subsequent lambing weight. Presumably, this was due to a greater utilization of GH by the tissues of the faster growing fetuses, thus indicating that GH is involved in the control of growth rate of the sheep fetus.

Monensin. During a 14-wk period, lambs fed a diet containing monensin at a level of 25 mg/kg gained 13.6% more in body weight than lambs fed a control diet free from monensin. Both groups consumed the same amount of feed, and the increased feed efficiency of the monensin-fed lambs coincided with a sharp decrease in coccidia in the lower digestive tract. The observation concerning the coccidia may explain the mechanism by which monensin helps to improve feed efficiency. It is suggested that the increase in feed efficiency of lambs fed the diet containing monensin resulted essentially from the control of low-grade pathogens such as coccidia in the lower digestive tract. The explanation that the improvement in feed efficiency by monensin is due to propionate production at the expense of acetate production in the rumen may have to be revised.

CROP ENTOMOLOGY

Forage crop insects

Seed crops. The cooperative integrated pest management program for seed alfalfa in the County of Newell is now operated by a private company at a nominal charge to participating growers. Sampling of alfalfa insect populations in southern Alberta indicated that alfalfa weevil populations were on the increase; chemical control was required for approximately 1000 ha. In general, lygus bugs, plant bugs, and pea aphids were at low levels although chemical control of lygus bugs was required in isolated fields in the Brooks area.

Studies on the parasites of the alfalfa weevil indicated that *Bathyplectus curculionis* Thompson was the most important, averaging 12% (5–25). *Perilitus rutilis* Ness., the egg parasite *Patassona luna* Girault., and the introduced parasites *Microctonus aethiopoides* Loan and *M. colesi* Drea. were not recovered in 1981.

The sainfoin seed parasite *Eurytoma onobrychidis* Nik., a native of eastern Europe and the USSR, was apparently accidentally introduced into North America with seed from which the cultivar Nova was developed. Damage estimates in cleaned breeder seed samples of Nova in 1979, 1980, and 1981 were 20.0, 5.8, and 11.2%. Preliminary studies indicate that this parasite can be controlled in seed by exposure to –40°C for 5 days without affecting the germination. However, infested seed pods tend to shatter before and during harvest, providing a source of reinfestation of the subsequent seed crop.

Pollinators. Although a small degree of self-pollination occurs in cicer milkvetch, yields can be significantly increased through cross-pollination by various pollinators. Bumble bees were the most efficient pollinators, producing significantly more seeds per pod and pollinating more flowers per unit of time than either honey bees or leafcutting bees.

Alfalfa forage crops. Aggregations of the ladybird beetle, *Hippodamia quinquesignata* Kirby, an important predator of the pea aphid in alfalfa, were found at several hibernation sites on the eastern edge of the Rocky Mountains and in the adjacent Porcupine Hills in southern Alberta. The beetles apparently migrate to these sites in the fall and return to the prairies in the spring. *H. quinquesignata* can survive Alberta winters, but some protection is needed because high mortality occurs in localized areas of these hibernation sites. Laboratory data indicate that the greatest protection against cold by supercooling occurs during midwinter. The most critical period for survival appears to be April and May, when a late spring cold period can cause high mortality because the beetles have lost their cold tolerance.

Cutworms

Sex attractants. In cooperation with European scientists, a multicomponent sex pheromone was identified from abdominal rinses of calling female moths of a turnip cutworm, *Agrotis segetum* Schiff., a pest in Europe and Japan. Concentrated rinses were analyzed by capillary gas chromatography combined with flame ionization detection, electroantennographic detection, and mass spectrometry for component identification. Under field conditions, a proportional five-component mixture was as attractive to males as were virgin

RESEARCH STATION, LETHBRIDGE, ALTA.

females and is currently being used for monitoring purposes.

Pheromone traps. The directional cone-orifice dry traps, baited with sex attractants, were suitable for monitoring five lepidopterous species provided that moth catches were low (<50 per trap); otherwise, captured moths had to be removed on a regular (weekly) basis throughout the flight period. An improved omnidirectional funnel trap, with a circular screen barrier in the entrance area and a slow-release insecticide formulation to kill captured moths, functioned well over an extended period of unattended use in the field. This trap would be more effective for monitoring, would require less maintenance, and could be used for mass trapping. The optimum quantity of attractant per dispenser was the same for both traps.

Population monitoring. For the 4th yr, density levels of male adults of eight noctuid species were recorded using sex attractant traps over a wide area of southern Alberta. Adult catches of army, clover, darksided, pale western, and redbacked cutworms were lower than in 1981. *Leucania commoides* adults increased slightly. Bertha armyworms showed a twofold increase throughout southern Alberta. At locations in the Lethbridge area, where traps caught over 700 adults, adjacent rape fields had larval populations that required control. The variegated cutworms that were trapped showed a marked increase in numbers over 1980 levels, but no larval infestations were reported.

Chemical control. Laboratory and greenhouse studies with larvae of the redbacked cutworm have demonstrated that four pyrethroid insecticides, deltamethrin, permethrin, cypermethrin, and fenvalerate, were more effective for controlling larvae than either endrin or chlorpyrifos. These less persistent pyrethroids will provide alternative controls that could have a reduced environmental impact.

Grasshoppers

Population studies. In 1981, the grasshopper survey was extended north to Lac la Biche (latitude 55°N) because of an extension of the area of infestation in 1980. Areas with moderate populations (three to five grasshoppers per square metre) and small pockets of severe infestation (more than five grasshoppers per square metre) were scattered throughout Alberta but were primarily centered at Lac la Biche in the north, Hughenden, Oyen, and Empress in the east, Castor and Stettler in the center, and Gleichen and Vulcan in the southern part of the survey area. Warm, dry weather in August in most localities provided a favorable egg-laying season. Populations are forecast to be higher and damage more extensive in 1982, unless spring weather conditions are unfavorable for the hatching nymphs.

Rangeland grasshoppers. A new method for estimating the damage potential of grasshoppers, based on the relationship between size and feeding rate, was used with the more abundant species sampled. At a study site on *Stipa–Agropyron* prairie, *Encoptolophus sordidus* Scudder, because of its abundance and high per capita feeding rate, had the greatest impact on forage production. Infestations of $10/m^2$ could cause a significant reduction in forage and induce significant pasture deterioration.

A computer simulation model was developed to predict daily changes in densities of eggs, nymphs, and adults of the migratory, clear-winged, and Packard's grasshoppers. Data to test the model were based on suction catches of nymphs and adults taken at a study site on alfalfa–bromegrass pasture in Saskatchewan. There was good agreement between simulated and observed density patterns. These studies also suggest that damage to pasture would be minimized if insecticide controls were applied when the nymphs were in the third stage.

Row crop insects

Although sex pheromone traps in the Medicine Hat area did not catch male moths of the European corn borer, an intensive larval survey collected corn borer larvae from 21 fields extending from Irvine to Bow Island. However, only one field of seed corn near Medicine Hat had a significant population. A cultural control program has been initiated in cooperation with Alberta Agriculture and the Quarantine Division of the Food Production and Inspection Branch of Agriculture Canada.

In a field experiment to control sugar beet wireworm in sugar beets, in-furrow treatments of turbufos 15G and fonofos 4EC provided the best protection. Bendiocarb 15G was the least effective but all three treatments increased plant stands and yields over those of

the untreated plots. Seed treatments were ineffective.

Insecticide residues

The persistence of fenvalerate residues on alfalfa was determined in three field experiments. Although variation occurred between experiments, associated with location, variety, row spacing, stand density, application date, and weather, an application rate of 0.14–0.15 kg/ha produced an initial residue of 22–33 mg/kg (dry weight basis) with a half-life of 9–11 days. Early-spring application (to take advantage of growth dilution) was negated by the effect of cooler temperatures, which slowed the degradation rate of fenvalerate. Degree-days, used to correlate fenvalerate degradation with both time and temperature, gave a more accurate expression of chemical half-life; it was 153–189 degree-days above 5°C.

The biological availability of fenvalerate residue in soil to *Aedes aegypti* larvae was investigated in aqueous suspension. Freshly treated soil at 0.4 mg/kg in suspension caused 57% larval mortality and, when compared with the standard aqueous bioassay, indicated that 14.8% of the fenvalerate residue was biologically available. When treated soil was dried overnight to simulate weathered residues, the bioassay produced 30% larval mortality, indicating that 2.7% of the residue was biologically available. This dried residue gave a fenvalerate concentration of 1.1 μg/kg in the 250-mL supernatant.

PLANT PATHOLOGY

Potato diseases

Light energy effects on bacterial ring rot symptoms. Ring rot symptoms were more severe on inoculated Red Pontiac potato stem cuttings grown under short high-light-energy periods (HLEP) of 8 h than on those grown under HLEP of 16 h. Ring rot symptoms were even more severe if stem cuttings were rooted under an 8-h HLEP prior to inoculation than if they were rooted under a 16-h HLEP. Extending or shortening low-light-energy periods had little effect on symptom development.

Forage crop diseases

Verticillium wilt of alfalfa. A national survey similar to that of 1980 on verticillium wilt of alfalfa was carried out by federal, provincial, and university plant pathologists in 1981. It covered the provinces surveyed in 1980, except British Columbia, where the disease has become well established.

In southern Alberta, verticillium wilt of alfalfa was found in 22 fields compared with 5 in 1980. It is mainly confined to irrigated fields in the Lethbridge, Picture Butte, and Taber districts. Disease incidence in southern Ontario also increased from one field in 1980 to 13 in 1981. In Saskatchewan, only one diseased field was confirmed this year compared with five in 1980. Verticillium wilt was found for the first time in Nova Scotia (three fields). It was not detected in Manitoba, Quebec, New Brunswick, or Prince Edward Island. In all, more than 850 fields were surveyed.

Cereal diseases

Ergot in wheat. Although grasses flowering late in the summer of 1980 in Alberta were heavily infected by *Claviceps purpurea*, thereby providing abundant inoculum for 1981, surveys of cereals showed that only the spring wheat in one small area of the province had a high incidence of ergot. In this area, 40% of the fields examined contained sufficient ergoty spikes for the grain to be downgraded on the basis of ergot content.

Stem smut of fall rye. The occurrence of stem smut of fall rye caused by the seed- and soil-borne fungus *Urocystis occulta* has increased from 1976 to 1981 in areas of intensive rye cultivation south of a line running through Olds–Drumheller–Oyen. Smut occurred in 36% of the fields of rye surveyed in 1981 and over the past 5 yr has occurred in 28% of the fields surveyed. Since 1976, the major control recommendations have been to grow the resistant cultivar Kodiak and to use the systemic seed treatment fungicide carbathiin. Unfortunately, Kodiak has not replaced the highly susceptible cultivar Cougar because farmers consider that Cougar is agronomically superior. However, material in the rye breeding program, aimed at providing a resistant cultivar agronomically superior to Cougar, is being screened for stem smut resistance. Although carbathiin has given variable results in controlling stem smut, its use has increased from

less than 1% to greater than 25% of seed cleaned at seed cleaning plants in southern Alberta. Control can vary from less than 50% to 100%. Sources of variation have been identified as rate, formulation and method of application, level and source of stem smut infestation, and the environmental conditions. A candidate fungicide that provides nearly complete control has been identified.

Coldhardiness of wheat

Very cold-hardy winter wheat plants develop a prostrate or rosette growth habit in the field in late autumn. Previously, plants grown under controlled environment conditions did not exhibit this form of growth. Plants exhibiting prostrate growth can now be produced in a growth cabinet if total light energy per day exceeds approximately 390 klx.h. Development of the rosette growth habit is correlated with, but not necessary for, high levels of coldhardiness in very hardy varieties. Plants lose their prostate growth habit or lose coldhardiness after the same duration of exposure to hardening conditions. Thus, retention of the prostrate growth habit can be used as a nondestructive indicator of retention of coldhardiness. Plants with prostrate growth should also be useful in testing for resistance to snow molds.

PLANT SCIENCE

Comparative growth of sorghum, wheat, and barley

Sorghum (*Sorghum bicolor* Moench 'Pride P130'), wheat (*Triticum aestivum* L. 'Neepawa'), and barley (*Hordeum vulgare* L. 'Galt') plants grown on dryland at Lethbridge were harvested at 1-wk intervals in 1976 and 1977 and separated into leaves, stems, heads, and seed. Whole-plant yields were higher in 1976 than in 1977, and sorghum whole-plant yields were higher than those of barley or wheat in both years. Sorghum grain yields were similar to those of barley but were greater than those of wheat. Although sorghum is about 40 days later maturing than barley or wheat, its whole-plant and filling-period durations were not very different from those of the other two crops. Sorghum used water more efficiently than wheat or barley under drought conditions. The biggest disadvantage of present sorghum hybrids appears to be slow growth in spring.

Corn

Corn heat unit requirements as influenced by location and hybrid. A study was conducted at 11 locations across Canada to determine whether corn hybrids have different corn heat unit (CHU) requirements in different climates. The study included six hybrids, four each in the 3-yr period 1977–1979. Differences in CHU requirements for the periods between planting and emergence and between anthesis and 45% ear moisture due to locations were probably the result of management and weather factors. In addition, at three locations with maritime climates, emergence to anthesis required 200 CHU more than at the other locations. Two hybrids required more CHU to emerge and one hybrid required more CHU from anthesis to 45% ear moisture than the other hybrids. These extra CHU requirements were not related to hybrid rating, that is, late-maturing hybrids do not require more CHU in the ripening phase. Genotypic differences were expressed mainly in differences in the period between emergence and anthesis. This phase of development was also the least variable among locations. Although CHU showed little advantage over growing degree-days as a thermal unit, it is a good choice for Canada.

Inheritance of flowering and tillering in early corn lines. A diallel cross and F_2 populations derived from eight early-maturing corn inbreds were used to investigate the inheritance of tillering and flowering time. Incomplete dominance for increased tillering was observed; potence ratios, representing the overall degree of dominance, ranged from 0.26 to 0.52. Dominance for early flowering ranged from incomplete with a potence ratio of 0.55 to overdominance with a potence ratio of 1.40. Broad-sense heritabilities were low for both characters. A significant negative linear relationship between tillering and flowering time was found. Lack of independent assortment of tillering and flowering time in F_2 populations indicated that the two characters are genetically related.

Diallel analysis of the number of days from emergence to flowering revealed a lack of agreement with the simple additive-dominance model of inheritance. Transforming the data for flowering time to the cumulative corn heat units (CHU) to flowering gave a better fit. Dominance was incomplete for low CHU to flowering. Positive (increasing CHU) and negative alleles, as well as dominant and

recessive alleles, were in about equal frequencies. Heritability estimates in the broad and narrow senses were high. The estimates of general combining ability were higher than the estimates of specific combining ability for flowering time.

Constituents and cooking quality of beans

Dry beans are an important crop in southern Alberta. About 3500 ha of beans are grown in the province, mainly pinto, pink, Great Northern, and red Mexican cultivars. The small white bean is not grown at present.

Alberta-grown small white beans turn soft when processed. In contrast, beans grown in Ontario, Michigan, or Idaho remain firm after processing. Consequently, Ontario beans or, if these are not available, Michigan or Idaho beans are preferred and are used in the beans-with-pork products processed in Alberta. The firm, mealy but not pasty texture of cooked beans determines consumer acceptability.

In a search for a possible cause of and solution to this problem, dry bean samples of Sanilac, Seafarer, Seaway, and Kentwood cultivars were obtained from Ontario and Alberta locations. The bean samples were analyzed for selected constituents. The results showed that Alberta-grown beans differed in most constituents from the same cultivars grown in Ontario. Kentwood grown in Alberta also differed from the Alberta-grown Sanilac, Seafarer, and Seaway cultivars.

The most notable differences were low total sugar and potassium contents and high fiber and calcium contents of Alberta-grown Sanilac, Seafarer, and Seaway cultivars. Alberta-grown Kentwood was higher in protein and potassium and lower in calcium than the same cultivar grown in Ontario. Tests are in progress to investigate the possible relationship between these differing constituents and the texture of processed (cooked) beans.

Forage

Range renovation. The conversion of native rangeland to seeded pastures generally requires that existing vegetation be completely eliminated through cultivation before the introduced species can be established. Other methods of range renovation involve the use of fertilizers or herbicides. Fertilizer applied in the fall to an *Agropyron–Stipa* rangeland at an N rate of 100 kg/ha in each of 3 yr, or as one application of N at 300 kg/ha at the start of the test, increased production of forage by 55%. Band spraying with glyphosate and then seeding a grass–legume mixture with a sod-drill increased forage production by 35%, and complete spraying over the whole plot and then seeding the forage mixture increased production by 50%. Seeding directly into the sod with a sod-drill resulted in no forage stand establishment and a slight reduction in yield of forage. Compared with untreated rangeland, complete tillage with a rotary tiller before seeding the forage crop resulted in an 80% increase in production over 4 yr.

Forage bale stackers. Two mover-stackers capable of handling four and six large round bales were developed by Olds Ag-Tech Industries Limited under the agricultural engineering research and development contracting-out program. The mover-stackers are unique in that they place the bales on end in columns two and three bales high, thus minimizing the size of the storage area. The mover-stackers are able to place the stacks in hay shelters previously used for storing rectangular bales. The mover-stacker can also be used for retrieving the bales from storage and unrolling them for feeding. In field trials, the mover-stacker was able to stack the bales with the top bale of each column placed on its side. This configuration was more stable and weather resistant than stacks with all bales placed on end. Olds Ag-Tech Industries is planning to market the mover-stacker.

SOIL SCIENCE

Soil–crop relations

Minimum tillage with winter wheat. Chemical weed control and tillage treatments were compared in three winter wheat rotations established on a clay loam soil: continuous winter wheat, winter wheat–fallow, and winter wheat–barley–fallow. Continuous winter wheat yield (2472 kg/ha) was about 70% of the winter wheat yield in the summerfallow rotations. The yields from the chemically treated plots were 13, 6, and 1% higher than those from the tilled plots for the continuous, 2-yr, and 3-yr winter wheat rotations. Barley's average yield increase was 12.5% after chemical treatment. The advantage of the chemical treatment over tillage occurred in years when the crop was exposed to dry conditions in the surface soil during the germination and early growth stages. Higher

moisture levels of the surface soil occurred in the chemically treated than in the tilled land at seeding time. The hoe drill was superior to the triple-disc drill when surface soil moisture was low at seeding.

Long-term dryland wheat rotations. Yields of wheat and moisture use efficiency on a dryland rotation started in 1912 have increased since 1963. These increases were more pronounced on fallow land than on stubble and occurred without the use of fertilizer. The upward trend in wheat yield coincided with the use of improved herbicides to control wild oats as well as broad-leaved weeds. We believe that reduced weed competition and better seedbed moisture because of fewer cultivations in the spring were the main contributing factors to the yield increases.

Phytotoxicity from worked-down winter wheat. In an experiment where winter wheat was worked down on 1 May because of spotty winterkill and the plots were immediately reseeded with spring wheat, there was no detrimental effect on yield. However, when workdown was delayed until after 15 May, yields of spring-seeded wheat were reduced by phytotoxicity from the decomposing winter wheat and by the effect of late seeding. On the other hand, phytotoxic effects on canola were minor and yield reductions were due mainly to late seeding.

Soil chemistry and microbiology

Carbon content and enzymatic activities in soil Ah horizons. Generally, total C was higher in samples from heavily grazed sites than in those from ungrazed sites. Water-soluble C was generally higher in soil from mixed prairie than in soil from fescue grassland except for short periods during the winter. Enzymatic activities were highest in samples from the fescue grassland sites regardless of grazing intensity. Enzymatic activities of both mixed prairie and fescue grassland increased during the winter months. Grazing intensity affected enzymatic activities differently in the two areas. At the mixed prairie site the dehydrogenase activity differed only slightly between the two grazing regimes, the phosphatase activity was decidedly greater in soil of the heavily grazed field than in that of the ungrazed field, and urease activity was lower. At the fescue grassland site the dehydrogenase and phosphatase activities were generally greater in soil of the ungrazed field than in that of the heavily grazed field whereas urease activity was lower. On the basis of these and other results, a model has been developed explaining the breakdown of root mass under semiarid to subhumid conditions during the period from late autumn to early summer.

Potassium status of soil after 66 yr of cropping. An irrigated rotation has supported high crop yields for 66 yr without the benefit of K fertilizer because of relatively high total K (14 392 mg/kg in the 0–15 cm layer and 11 183 mg/kg in the 15–30 cm layer) in the soil. Under native conditions, this K status was due to the nature of the parent material, biocycling, and minimal leaching. After two-thirds of a century of intensive cropping, the exchangeable K was reduced by 28% in the 0–15 cm layer. Extractable K (NaTPB method) decreased progressively from 2023 mg/kg in the 0–15 cm layer to 1368 mg/kg in the 45–60 cm layer in an adjacent native sod soil but there was no appreciable change in levels of NaTPB-K in the cropped soil. Apparently, some of the readily extractable K from micaceous minerals or feldspars, or both, was converted to exchangeable K as the pool of exchangeable K was depleted through continued cropping. Critically low levels of exchangeable and extractable K have not been reached.

Nitrogen losses from denitrification in soils. The microbial potential for the process of denitrification and the effects of sulfur anions on this process were assessed in five Alberta soils. The denitrification potential of the various soils was ranked as follows: Black (140 μg NO_3-N denitrified in 24 h) > Dark Brown (33 μg NO_3-N) > Brown (0 μg NO_3-N) ≈ Gray Luvisol ≈ Solodized Solonetz. The rate of denitrification in any soil was dependent on chemical characteristics and availibility of a suitable carbon substrate for the denitrifying microorganisms. Denitrification was stimulated in three of the last four soils by adding glucose-C at 300 μg/g of soil. Addition of SO_4^{-2}-S at 100 or 500 μg/g of soil had little or no effect on the rate of denitrification. In contrast, soils with added Na_2SO_3, $Na_2S_2O_3$, and Na_2S had reduced rates of denitrification, and nitrite accumulated. The data suggest that microbial reduction of these sulfur anions to S^{2-} occurred and that S^{2-} blocked the terminal steps of the enzyme pathway for denitrification, resulting in the accumulation of NO_2^-. The inhibition of denitrification by the sulfur anions could be

overcome by adding glucose-C at 900 μg/g of soil.

Nitrogen fixation with wheat. Wheat, Western Canada's most important crop, yields well only with high levels of available nitrogen. Recent research at the Lethbridge Research Station has shown that N_2-fixing bacteria can associate with roots of wheat and can fix N_2 from the air, thus providing nitrogen for the wheat plant. Up to 30% of the plant's nitrogen may be derived from this bacterial N_2 fixation. When tested, approximately one-quarter of the wheat cultivars grown in Western Canada exhibited an ability to benefit from bacterial N_2 fixation. Research to breed this trait into other nonfixing cultivars, to increase the amounts of N_2 fixed, and therefore to reduce dependence on expensive fertilizer nitrogen is planned.

Recovery of mycorrhizal spores from soil. A method for recovering live vesicular-arbuscular mycorrhizal spores from large soil samples was developed. The method allows recovery of the spores without the need for expensive equipment and separatory solutions. Spores, along with organic detritus and nematodes, are separated from soil particles by wet sieving (>63 μm) and further purified by flotation on 50% glycerol. The organic material is then suspended in Ringer's saline solution and the spores are separated from other organic material by centrifuging (10 min at 75 × *g*) the mixture on a two-layer discontinuous solution gradient, consisting of 50% glycerol (1.13 g/cm³) overlaid with 30% glycerol (1.08 g/cm³). After initial flotation 84% of the spores present were recovered. Using this technique, it is possible to separate approximately 18 000 vesicular-arbuscular spores from 180 kg of soil in 3.5 days.

Irrigated soils

Long-term irrigation and soil salinity. The average total soluble salts to the 180-cm depth in two soils near Tilley, Alta., have decreased logarithmically since 1917. The average Ca content decreased linearly at rates of 0.091 and 0.097 meq/100 g soil annually in a clay and a clay loam soil, respectively. The results indicate that irrigation management at the two sites, achieving a leaching fraction of 0.16, provided sufficient leaching water to reduce the total soluble salts and improve the soil for crop production.

Irrigation with rendering-plant effluent. Plots were irrigated for 5 yr with irrigation water, two levels of rendering-plant waste water (providing N at 500 and 1000 kg/ha per year), and irrigation water supplemented with N and P to the equivalent concentration found in the waste water. The waste water had a biological oxygen demand equivalent to C at 600 μg/kg and contained N (mainly NH_4^+) at about 600 μg/kg and P at 30 μg/kg. Forage yields were similar from the plots irrigated with waste water or with irrigation water supplemented with N and P. Yields were lower in plots receiving unsupplemented irrigation water. At the highest rate of waste water application (N at 1000 kg/ha per year), leaching of nitrate below the root zone was observed, but no leaching occurred with the lower application rate (N at 500 kg/ha per year). No accumulation of salts in the soils receiving waste water was detected.

PUBLICATIONS

Research

Bailey, C. B. 1981. Silica metabolism and silica urolithiasis in ruminants: A review. Can. J. Anim. Sci. 61:219-235.

Bailey, C. B.; Lawson, J. E. 1981. Estimated water and forage intakes in nursing range calves. Can. J. Anim. Sci. 61:415-421.

Bole, J. B.; Carefoot, J. M.; Chang, C.; Oosterveld, M. 1981. Effect of waste water irrigation and leaching percentage on soil and ground water chemistry. J. Environ. Qual. 10:177-183.

Bowden, D. M. 1981. Feed utilization for calf production in the first lactation by 2-year-old F_1 crossbred beef cows. J. Anim. Sci. 51:304-315.

Byers, J. R.; Underhill, E. W.; Steck, W. F.; Chisholm, M. O.; Teal, P. E. A. 1981. Biosystematics of the genus *Euxoa* (Lepidoptera: Noctuidae) XV. Sex pheromone cross attractancy among the three closely related species of the *declarata* group. Can. Entomol. 113:235-243.

Chang, C.; Oosterveld, M. 1981. Effect of long-term irrigation on soil salinity at selected sites in southern Alberta. Can. J. Soil Sci. 61:497-505.

Cheng, K.-J.; Fay, J. P.; Coleman, R. N.; Milligan, L. P.; Costerton, J. W. 1981. Formation of bacterial microcolonies on feed particles in the rumen. Appl. Environ. Microbiol. 41:298-305.

Cheng, K.-J.; Irvin, R. T.; Costerton, J. W. 1981. Autochthonous and pathogenic colonization of animal tissues by bacteria. Can. J. Microbiol. 27:461-490.

Cogley, T. P.; Anderson, J. R.; Weintraub, J. 1981. Ultrastructure and function of the attachment organ of warble fly eggs (Diptera: Oestridae: Hypodermatinae). Int. J. Insect Morphol. Embryol. 10:7-18.

Costerton, J. W.; Irvin, R. T.; Cheng, K.-J. 1981. The bacterial glycocalyx in nature and disease. Annu. Rev. Microbiol. 35:299-324.

Dormaar, J. F.; Smoliak, S.; Johnston, A. 1981. Seasonal fluctuations of blue grama roots and chemical characteristics. J. Range Manage. 34:62-64.

Dubetz, S.; Dudas, M. J. 1981. Potassium status of a Dark Brown Chernozem soil after sixty-six years of cropping under irrigation. Can. J. Soil Sci. 61:409-415.

Fay, J. P.; Cheng, K.-J.; Costerton, J. W. 1981. Alkaline phosphatase activity associated with the walls of different organs of the gastrointestinal tract in newborn, young and yearling bovines: Effects of diet and fasting. Can. J. Anim. Sci. 61:311-318.

Fay, J. P.; Cheng, K.-J.; Hanna, M. R.; Howarth, R. E.; Costerton, J. W. 1981. A scanning electron microscopy study of the invasion of leaflets of a bloat-safe and a bloat-causing legume by rumen microorganisms. Can. J. Microbiol. 27:390-399.

Fredeen, H. T.; Weiss, G. M.; Rahnefeld, G. W.; Lawson, J. E.; Newman, J. A. 1981. Growth patterns of first-cross cows under two environments. Can. J. Anim. Sci. 61:243-259.

Gardiner, E. E.; Dubetz, S. 1981. Hatchability of eggs and performance of SCWL broiler breeder hens fed soybean meal and fababean meal diets. Can. J. Anim. Sci. 61:449-452.

Gardiner, E. E.; Dubetz, S.; Major, D. J. 1981. Sorghum, wheat and corn in diets for broiler chickens. Can. J. Anim. Sci. 61:511-513.

Gould, W. D.; Bryant, R. J.; Trofymow, J. A.; Anderson, R. V.; Elliott, E. T.; Coleman, D. C. 1981. Chitin decomposition in a model soil system. Soil Biol. Biochem. 13:487-492.

Grzesiak, S.; Rood, S. B.; Freyman, S.; Major, D. J. 1981. Growth of corn seedlings: Effects of night temperature under optimum soil moisture or under drought conditions. Can. J. Plant Sci. 61:871-877.

Hanna, M. R. 1981. Registration of Nova sainfoin (Reg. No. 22). Crop Sci. 21:987.

Haufe, W. O. 1980. Facing the challenge of a new decade for biometeorology. Int. J. Biometeorol. 24:177-178.

Hawn, E. J.; Berkenkamp, W. B.; Lebeau, J. B. 1981. Evaluation of losses in alfalfa hay production caused by crown rot. Can. J. Plant Pathol. 3:103-105.

Hill, B. D. 1981. Persistence and distribution of fenvalerate residues in soil under field and laboratory conditions. J. Agric. Food Chem. 29:107-110.

Hobbs, E. H. 1981. Improving farm irrigation management by incorporating water table effects into scheduling programs. 11th Congr. Int. Comm. Irrig. and Drainage, Grenoble, France. R. 30, Quest. 36:491-496.

Hobbs, E. H.; Krogman, K. K. 1981. Sorghum and barley in southern Alberta: Grain yield response to irrigation and fertilizer. Can. J. Plant Sci. 61:837-843.

Huang, H. C. 1981. Tan sclerotia of *Sclerotinia sclerotiorum*. Can. J. Plant Pathol. 3:136-138.

Khan, M. A. 1981. An intradermal test to detect latent warble (*Hypoderma* spp.) infection in cattle. Can. Vet. J. 22:36-41.

Khan, M. A. 1981. Protection of pastured cattle from black flies (Diptera: Simuliidae): Improved weight gains following a dermal application of phosmet. Vet. Parasitol. 8:327-336.

Klein, K. K.; Salmon, R. E.; Gardiner, E. E. 1981. Economic analysis of the use of canola meal in diets for broiler chickens. Can. J. Agric. Econ. 29:327-338.

Larson, R. I.; Atkinson, T. G. 1981. Reaction of wheat to common root rot: Identification of a major gene, *Crr*, on chromosome 5B. Can. J. Genet. Cytol. 23:173-182.

Lawson, J. E. 1981. Feedlot and carcass traits of progeny of dams of the Highland and Hereford breeds and their reciprocal crosses. Can. J. Anim. Sci. 61:27-34.

Lindwall, C. W.; Anderson, D. T. 1981. Agronomic evaluation of minimum tillage systems for summer fallow in southern Alberta. Can. J. Plant Sci. 61:247-253.

MacKay, D. C.; Carefoot, J. M. 1981. Control of water content in laboratory determination of mineralizable nitrogen in soils. Soil Sci. Soc. Am. J. 45:444-446.

Majak, W.; Cheng, K.-J. 1981. Identification of rumen bacteria that anaerobically degrade aliphatic nitrotoxins. Can. J. Microbiol. 27:646-650.

Major, D. J.; Hamman, W. M. 1981. Comparison of sorghum with wheat and barley grown on dryland. Can. J. Plant Sci. 61:37-43.

McClellan, J. F.; Anderson, R. V.; Gould, W. D.; Rubink, A. J.; Coleman, D. C. 1981. Plant culture for observing associated protozoa and other rhizosphere organisms. Am. Midl. Nat. 106:406-410.

McDonald, S. 1981. Evaluation of organophosphorous and pyrethroid insecticides for control of the pale western cutworm. J. Econ. Entomol. 74:45-48.

McDonald, S. 1981. Laboratory evaluation of new insecticides for control of redbacked cutworm larvae. J. Econ. Entomol. 74:593-596.

Mears, G. J.; Lai, P. C. W.; Van Petten, G. R.; Lorscheider, F. L. 1981. Fetal-maternal transfer and catabolism of ovine ^{125}I-labeled α-fetoprotein. Am. J. Physiol. 240(Endocrinol. Metab. 3):E191-E196.

Moyer, J. R.; Chow, P. N. P.; Dryden, R. D. 1981. Triallate herbicide application with dry and solution nitrogen fertilizers. Can. J. Plant Sci. 61:107-114.

Nelson, W. A. 1981. *Melophagus ovinus* (Pupipara: Hippoboscidae): Confirmation of the nonpathogenicity of *Trypanosoma melophagium* for sheep keds. J. Invertebr. Pathol. 37:284-289.

Pace, M. M.; Sullivan, J. J.; Elliott, F. I.; Graham, E. F.; Coulter, G. H. 1981. Effects of thawing temperature, number of spermatozoa and spermatozoal quality on fertility of bovine spermatozoa packaged in 5-ml French straws. J. Anim. Sci. 53:693-701.

Rennie, R. J. 1981. A single medium for the isolation of acetylene-reducing (dinitrogen-fixation) bacteria from soil. Can. J. Microbiol. 27:8-14.

Rennie, R. J.; Kemp, G. A. 1981. Dinitrogen fixation in pea beans (*Phaseolus vulgaris*) as affected by growth stage and temperature regime. Can. J. Bot. 59:1181-1188.

Rennie, R. J.; Kemp, G. A. 1981. Selection for dinitrogen-fixing ability in *Phaseolus vulgaris* L. at two low-temperature regimes. Euphytica 30:87-95.

Rood, S. B.; Major, D. J. 1981. Inheritance of tillering and flowering-time in early maturing maize. Euphytica 30:327-334.

Rood, S. B.; Major, D. J. 1981. Diallel analysis of leaf number, leaf development rate, and plant height of early maturing maize. Crop Sci. 21:867-873.

Russell, K. D.; Hironaka, R.; Wilson, D. B. 1981. An economic analysis of alternative management techniques for beef production on irrigated pastures in Alberta. Can. Farm Econ. 16(4):1-7.

Schaber, B. D. 1981. Description of the immature stages of *Dioryctria taedae* Schaber and Wood, with notes on its biology and that of *D. disclusa* Heinrich (Lepidoptera: Pyralidae). Proc. Entomol. Soc. Wash. 83:680-689.

Shemanchuk, J. A. 1981. Repellent action of permethrin, cypermethrin and resmethrin against black flies (*Simulium* spp.) attacking cattle. Pestic. Sci. 12:412-416.

Stewart, C. S.; Paniagua, C.; Dinsdale, D.; Cheng, K.-J.; Garrow, S. H. 1981. Selective isolation and characteristics of *Bacteroides succinogenes* from the rumen of a cow. Appl. Environ. Microbiol. 41:504-510.

Stockdale, P. H. G.; Bainborough, A. R.; Bailey, C. B.; Niilo, L. 1981. Some pathophysiological changes associated with infection of *Eimeria zuernii* in calves. Can. J. Comp. Med. 45:34-37.

Struble, D. L. 1981. A four-component pheromone blend for optimum attraction of redbacked cutworm males, *Euxoa ochrogaster* (Guenée). J. Chem. Ecol. 7:615-625.

Struble, D. L. 1981. Modification of the attractant blend for adult males of the army cutworm, *Euxoa auxiliaris* (Grote), and the development of an alternate 3-component attractant blend for this species. Environ. Entomol. 10:167-170.

Taylor, W. G. 1981. Synthesis of 5,5-dichloro-4-pentenoic acid by the Wittig reaction with bromotrichloromethane and triphenylphosphine. J. Org. Chem. 46:4290-4292.

Thomas, J. B.; Valtsikes, D. T.; Anderson, R. G. 1980. Relation between wheat–rye crossability and seed set of common wheat after pollination with other species in the Hordeae. Euphytica 30:121-127.

Traquair, J. A.; Kokko, E. G. 1981. Spore discharge in *Epicoccum nigrum*. Can. J. Bot. 59:59-62.

RESEARCH STATION, LETHBRIDGE, ALTA.

Underhill, E. W.; Steck, W. F.; Byers, J. R.; Chisholm, M. D. 1981. Biosystematics of the genus *Euxoa* (Lepidoptera: Noctuidae): XVI. (*Z*)-5-decenyl acetate a sex attractant for three closely related species, *Euxoa declarata, Euxoa campestris,* and *Euxoa rockburnei*. Can. Entomol. 113:245-249.

Vesely, J. A.; Peters, H. F. 1981. Lamb production from ewes of four breeds and their two-, three-, and four-breed crosses. Can. J. Anim. Sci. 61:271-277.

Whelan, E. D. P. 1981. Cytoplasmic male sterility in *Helianthus giganteus* L. × *H. annusis* L. interspecific hybrids. Crop Sci. 21:855-858.

Miscellaneous

Coulter, G. H. 1981. High dietary energy can decrease reproductive performance in young beef bulls. Can. Agric. 26(1):22-23.

Croome, G. C. R.; Atkinson, T. G., eds. 1981. Research highlights—1980. Agriculture Canada Research Station, Lethbridge, Alta. 71 pp.

Hironaka, R.; Sonntag, B. H. 1981. Feedlot finishing of cattle. Agric. Can. Publ. 1591 (rev.).

Mains, W. H.; Major, D. J. 1981. Corn silage: Reduction of moisture content by adding barley grain or straw. Forage Notes 25:40-45.

Rennie, R. J. 1981. Diazotrophic biocoenosis. Pages 253-258 *in* Vose, P. B.; Ruschel, A. P., eds. Associative N_2 fixation, Vol. II. CRC Chemical Press.

Rennie, R. J.; Larson, R. I. 1981. Dinitrogen fixation associated with disomic chromosome substitution lines of spring wheat in the phytotron and in the field. Pages 145-154 *in* Vose, P. B.; Ruschel, A. P., eds. Associative N_2 fixation, Vol. I. CRC Chemical Press.

Richards, K. W. 1981. Controlled temperature room for alfalfa leafcutter bees. Canadex 616.

Smoliak, S.; Bjorge, M.; Penney, D.; Harper, A. M.; Horricks, J. S. 1981. Alberta forage manual (4th rev.). Alberta Horticulture, Edmonton, Agdex 120/20-4. 87 pp.

Smoliak, S.; Johnston, A.; Lodge, R. W. 1981. Managing crested wheatgrass pastures. Agric. Can. Publ. 1473/E.

Traquair, J. A. 1981. Discovery of a sporulating state for the LTB snow mold. Can. Agric. 26(1):18-20.

Research Station
Agassiz, British Columbia

PROFESSIONAL STAFF

J. E. Miltimore, B.S.A., M.Sc., Ph.D.	Director
D. H. Frey, B.Sc.	Analyst Programmer
J. Repstock	Administrative Officer
M. C. Vidal,[1] B.A., M.L.S.	Librarian

Animal Science

J. R. Hunt, B.S.A., Ph.D.	Head of Section; Poultry physiology
W. T. Buckley, B.Sc., Ph.D.	Ruminant mineral biochemistry
L. J. Fisher, B.S.A., M.Sc., Ph.D.	Dairy cattle nutrition
R. J. Forrest, B.S.A., M.S.A., Ph.D.	Animal physiology, meat studies
E. E. Gardiner, B.Sc., M.Sc., Ph.D.	Poultry nutrition

Crop Science

J. A. Freeman, B.S.A., M.S.A., Ph.D.	Head of Section; Physiology of small fruits, herbicides
S. G. Fushtey, B.Sc., M.Sc., Ph.D.	Turf management, cereals
J. C. W. Keng, B.Sc., M.Sc., Ph.D.	Crop and soil management
C. G. Kowalenko, B.S.A., M.Sc., Ph.D.	Soil biochemistry and fertility
A. R. Maurer, B.S.A., M.Sc.	Physiology of vegetable crops
P. W. Perrin, B.Sc., Ph.D.	Postharvest physiology

Departures

N. A. Fairey, B.Sc., M.Sc., Ph.D. Transferred to Agriculture Canada Research Station, Beaverlodge, Alta., July 1981	Field crop physiology
E. F. Maas, B.S.A., M.Sc. Retired 30 December 1981	Plant nutrition, nonsoil media
D. C. Ottoson, B.A. Transferred to Agriculture Canada Research Station, Kentville, N.S., June 1981	Analyst Programmer

M. I. TUTTLE, B.Sc., B.L.S. — Librarian
Transferred to Canada Institute for Scientific and Technical Information, Ottawa, Ont., June 1981

---

[1]Seconded from Libraries Division, Finance and Administration Branch.

INTRODUCTION

Mr. E. F. Maas retired after many years of research in support of the ornamental and greenhouse vegetable industries. His research resulted in the greenhouse and nursery trades using sawdust instead of soil as a growth medium.

The most significant discovery during 1981 was the development of a method of utilizing stable isotopes of copper to replace use of radioactive copper isotopes in studying copper metabolism in cattle. Stable isotopes can be used in long-term experiments and less expensive facilities are required for their use; this principle is particularly suitable for research into the copper requirements of humans.

Highlights of results achieved in 1981 are given in the report. The list of publications provides a more extensive indication of achievements. Requests for information on these and other projects should be directed to the Research Station, Agriculture Canada, P.O. Box 1000, Agassiz, B.C. V0M 1A0.

J. E. Miltimore
Director

ANIMAL SCIENCE

Use of stable isotopes of copper in animal nutrition

A newly developed procedure utilizes a stable isotope of copper, copper-65, to replace radioactive isotopes of copper in animal nutrition research. Experiments can now be performed that used to be prohibitively expensive because of the safety requirements for the use of radioactive substances. In addition, many experiments that could not be performed because of the short life of copper radioisotopes can now be undertaken using copper-65.

Natural copper is composed of two stable isotopes that are present in a fixed ratio—approximately 30% copper-65 and 70% copper-63. The natural ratio of the two isotopes can be altered in an animal's body by feeding or injecting copper-65. Because the only source of natural copper to the animal is in its diet, it is possible to make conclusions about copper nutrition by observing the rate at which the altered ratio of copper isotopes returns to the natural ratio in various organs and body fluids.

The new procedures involve preparing copper in a volatile, chelated form from biological samples and using the techniques for the mass spectrometric analysis of the stable isotope ratio of the copper on a routine basis. The method should also be particularly useful in the study of factors affecting the copper requirements of humans.

Whey as an energy source for calves

In a cooperative study with the Fraser Valley Milk Producers Association, evaporated whey (60% solids), to which was added 1% canola meal, was fed to calves as a source of energy and protein. The product was palatable and provided a suitable supplement to forage rations. However, when grain was fed with the whey, bloat became a problem. Calves consumed up to 3 kg dry matter of whey per day or 55% of total dry matter intake and attained an average rate of gain of 1 kg/day. Results suggest a value of $0.315/kg of dry matter for the evaporated whey–canola meal product when fed to calves.

Variation in vicine and convicine content of faba bean (*Vica faba* L.) genotypes

Faba beans, which have a protein content of 25–30%, have been investigated as an alternative protein source for poultry. Although results of feeding trials have varied, growth rate, feed efficiency, egg weight, egg production, body weight, and hatchability of eggs have generally been reduced. Faba beans contain the pyrimidene glucosides vicine and convicine, which are a likely cause of the adverse results. The content of these two glucosides in faba beans was determined by reverse-phase liquid chromatography of samples of 78 faba bean genotypes grown on irrigated land and harvested at maturity. The vicine content ranged from 0.45% to 0.90% with a mean of 0.59 (SD ±0.08). Although the concentration of convicine was lower than

vicine within cultivars (except one), there was greater variability between cultivars for convicine (range 0.15–0.54%; mean 0.26, SD ±0.07). The total glucoside concentration among genotypes varied from 0.69 to 1.26%. The negative correlation coefficient ($r = -0.025$) between vicine and convicine within cultivars was not significant, supporting the conclusion that the two glucosides are genetically independent.

Restricted energy consumption of laying hens

A study designed to limit the intake of dietary energy fed to laying hens, while providing adequate protein intake, was conducted. When limitation was dependent upon the intake of birds with free access to feed at all times, based on the number of birds that started the experiment, production was unaffected by restriction of energy intake by as much as 8% (1218 kJ/day for full-fed birds compared to 1122 kJ/day for restricted birds). Egg size was slightly reduced by energy restriction but was not of economic importance. Mortality was highest (12.4%) for the full-fed hens and lowest (1.6%) for those restricted by 8%. In this experiment with 250 birds per treatment, large differences were required to measure differences in mortality due to feed intake levels.

If energy intake was set at a fixed amount per day, then the selected levels lead to the restriction of energy intake by 15 and 19%. These levels of restriction caused slightly reduced levels of production, but a reduction in mortality over the full-fed birds had the effect of equalizing performance.

Statistical analysis suggests that the mean energy requirement for the maintenance of maximum egg mass yield is between 1088 and 1130 kJ/day.

CROP SCIENCE

Herbicide–insecticide interactions

Herbicides and insecticides are often used concurrently in the production of vegetable crops. Information is essential on the compatability of herbicides and insecticides applied to field-seeded crops. Compatability is defined as the ability of the plant-protective materials to be used together without loss of effectiveness or damage to the crop.

Over the past 12 yr, the effectiveness of several herbicides and insecticides, and their compatability when applied to field-seeded brassica crops and sweet corn, were investigated.

Twenty-seven herbicides and three insecticides were tested in 220 combinations. Twenty-nine resulted in phytotoxic interactions in rutabaga, 26 in broccoli, 20 in cabbage, and 8 in cauliflower. Each of the three insecticides thionazin, fensulfothion, and carbofuran were involved in one or more phytotoxic combinations in each of the four crops. Twelve herbicides were involved in phytotoxic reactions, none had insecticidal properties, and some decreased the effectiveness of the insecticides.

Thiocarbamate herbicides were tested with the insecticide fonofos on Golden Jubilee sweet corn. A significant portion of the corn treated with Eradicane plus fonofos showed malformed ears. Follow-up studies identified 10 sweet corn cultivars as extremely susceptible to the Eradicane–fonofos combination, and nine were tolerant. It appears that early maturing types escape injury. The results were not consistent each year, possibly because of the variable effect of soil and weather on plant–pesticide interactions. Nevertheless, the data show that economic losses may occur in field-sown vegetables when certain herbicides are applied simultaneously or within a short period of applying insecticides. The results emphasize the importance of cooperation between scientists studying different phases of crop production, including integrated pest-management systems.

Leaf spot disease in Kentucky bluegrass

Sixty cultivars of Kentucky bluegrass were evaluated for resistance to the leaf spot (melting-out) disease over a 2-yr period (1980-1981). Seven (Merion, Nugget, Baron, Bristol, Touchdown, Birka, and Enmundi) among 20 licensed cultivars in the test exhibited a high level of resistance to this disease, less than 5% damage. The most susceptible cultivar (Park) suffered more than 30% stand reduction. *Helminthosporium vagans* (isolated from leaf lesions) was probably the primary pathogen, but *Fusarium* spp. were also consistently present.

Broccoli responds to nitrogen fertilization

Broccoli was shown to have comparatively high nitrogen requirements. On adjacent field plots, broccoli responded to ammonium nitrate application, but sweet corn did not.

Uptake of N by broccoli (171 kg/ha) into aboveground material was higher than uptake of N by sweet corn (135 kg/ha) when both were treated with a fertilizer with an N level of 224 kg/ha. This relatively high uptake of N by broccoli occurred despite the much lower dry matter production (4.7 t/ha) than that of sweet corn (9.4 t/ha). The concentration of N in broccoli (3.7%) was much higher than in sweet corn (1.4%). Nitrogen application increased the relative proportion of the head to the total aboveground broccoli production. Chemical analysis of the head showed high concentrations of N, indicating that the head accumulates considerable N during growth.

Overcoming the toxicity of cedar sawdust to plants

Tomato seedlings that were bare-root transplanted into red cedar sawdust grew more poorly than either seedlings that were transplanted into cedar sawdust with their roots encased in the original peat-based potting medium, or bare-root transplants planted into hemlock sawdust. The growth of nursery plants transplanted without root disturbance from 10-cm pots into 25-cm pots of red cedar sawdust equaled that of plants transplanted into fir or hemlock sawdust. Sawdust from mature cedar trees was extremely toxic to vegetable seedlings, but sawdust from cedar trees less than 60 cm in diameter was equal or superior to fir and hemlock sawdusts.

Further research showed that leaching with water did not adequately remove the toxic components from cedar sawdust derived from mature trees. However, aging the moistened sawdust for 2–6 mo at room temperature allowed test crops of bean, pea, and tomato seedlings to be grown therein, though the fresh cedar sawdust severely reduced their growth rates.

Planting dates for overwintered cauliflower

Cauliflower plants started in mid-July (16, 17) tended to become too large and were less frost tolerant. Plants started in early August (5, 6) were not sufficiently developed by winter, but were frost tolerant and produced small heads at harvest. Plants started in late July (26, 27) were sufficiently frost tolerant and produced medium-sized but marketable heads at harvest. Time of head formation was not affected by date of planting. The larger plants developed the largest heads.

Color enhancement in poststorage cabbage

Cabbages removed in March, even from the best storages, normally require moderate to heavy trimming of outer leaves owing to senescence and decay. The result is a pale product that competes poorly with brightly colored cabbages harvested at more southerly latitudes. Although more sophisticated storage facilities, including the use of controlled atmosphere, may provide significant improvements in cabbage-keeping quality, the cost may not be warranted; some other means is required to ensure that cabbages of competitive quality are available at a reasonable cost.

Two cultivars received treatments of light, temperature, and nutrient sprays to determine if color enhancement were possible in pale, trimmed cabbages that had been stored for 4 mo. Analysis showed that elevated temperatures and illumination increased chlorophyll significantly, whereas nutrient sprays produced a smaller effect. The combined effect of elevated temperature and illumination resulted in more than a 50% greater increase in chlorophyll concentration than did either treatment alone.

PUBLICATIONS

Research

Buckley, W. T.; Marquardt, R. R. 1981. Estimation of whole body protein synthesis in rats by single injection of L-(1-^{14}C)leucine or DL-(1-^{14}C) lysine. J. Nutr. 111:763-771.

Buckley, W. T.; Marquardt, R. R.; Ward, A. T. 1981. Effect of rate of catabolism of DL-(1-^{14}C)lysine on estimation of whole body protein synthesis in rats. J. Nutr. 111:772-776.

Buckley, W. T.; Tait, R. M. 1981. Chronic copper toxicity in lambs: A survey of blood constituent responses. Can. J. Anim. Sci. 61:613-624.

Fisher, L. J. 1981. The consumption of acid whey by lactating cows. Can. J. Anim. Sci. 61:209-211.

Fisher, L. J.; Zurcher, P.; Shelford, J. A.; Skinner, J. 1981. Quantity and nutrient content of effluent losses from ensiled high moisture grass. Can. J. Anim. Sci. 61:307-312.

Forrest, R. J. 1981. A comparison of the growth, feed efficiency and carcass characteristics between purebred Holstein–Friesian steers and Limousin × Holstein (F_1) steers and heifers. Can. J. Anim. Sci. 61:515-521.

Forrest, R. J. 1981. Effect of high concentrate feeding on carcass quality and fat colouration of grass-reared steers. Can. J. Anim. Sci. 61:575-580.

Fushtey, S. G.; Frank, R. 1981. Distribution of mercury residues from the use of mercurial fungicides on golf course greens. Can. J. Soil Sci. 61:525-527.

Gardiner, E. E.; Dubetz, S. 1981. Hatchability of eggs and performance of SCWL and broiler breeder hens fed soybean meal and fababean meal diets. Can. J. Anim. Sci. 61:449-452.

Gardiner, E. E.; Dubetz, S.; Major, D. J. 1981. Sorghum wheat and corn in diets for broiler chicks. Can. J. Anim. Sci. 61:511-513.

Hill, A. T.; Hunt, J. R. 1981. Effect of cage floor shape on layer performance. Can. J. Anim. Sci. 61:817-825.

Kowalenko, C. G. 1981. Effect of immobilization on nitrogen transformations and transport in a field ^{15}N experiment. Can. J. Soil Sci. 61:387-395.

Kowalenko, C. G. 1981. Effects of magnesium and potassium applications on yields and leaf nutrient concentrations of red raspberries and on soil analyses. Commun. Soil Sci. Plant Anal. 12:795-811.

Kowalenko, C. G.; Maas, E. F.; Van Laerhoven, C. J. 1980. Residual effects of high rates of limestone, P, K and Mg applications: Evidence of induced Mn and Zn deficiency in oats. Can. J. Soil Sci. 60:757-761.

Schneider, F.; Shelford, J. A.; Peterson, R. J.; Fisher, L. J. 1981. Effects of early and later breeding of dairy cows on reproduction and production in current and subsequent lactation. J. Dairy Sci. 64:1996-2002.

Miscellaneous

Buckley, W. T.; Huckin, S. N.; Eigendorf, G. K. 1981. Trace metal analysis by mass spectrometric stable isotope technique. Proc. 64th Conf. Chem. Inst. Can., Halifax, N.S. (May). p. 144.

Fushtey, S. G. 1980. Chemical control of snow mold in bentgrass turf in Southern Ontario. Can. Plant Dis. Surv. 60:25-31.

Fushtey, S. G. 1981. Control of moss in lawns. Canadex 273-646.

Fushtey, S. G.; Harmsen, P. B. 1980–1981. Cereal cultivar evaluation trials. Agassiz Res. Stn. 9 pp.

Fushtey, S. G.; Harmsen, P. B. 1981. Turfgrass cultivar evaluation trials. Agassiz Res. Stn. 11 pp.

Miltimore, J. E.; Keng, J. C. W.; Frey, D.; Jewell, M. 1981. Weather observations for 1981—Summaries and averages for 90 years of continuous recording. Agassiz Res. Stn. 9 pp.

Research Station
Kamloops, British Columbia

PROFESSIONAL STAFF

J. D. McElgunn, B.Sc., M.Sc., Ph.D.	Director; Forage physiology
W. L. Pringle, B.S.A., M.S.F.	Superintendent, Prince George; Ecology, forage
K. Broersma, B.S.A., M.Sc.	Forage agronomy and soils, Prince George
A. McLean, B.S.A., M.Sc., Ph.D., F.A.I.C., F.S.R.M.	Range ecology
W. Majak, B.Sc., M.Sc., Ph.D.	Plant biochemistry
D. A. Quinton, B.S., Ph.D.	Range science
D. G. Stout, B.S.A., M.Sc., Ph.D.	Plant physiology
A. L. van Ryswyk, B.S.A., M.S.A., Ph.D.	Soil science

INTRODUCTION

The research programs at the Range Research Station, Kamloops, and at the Experimental Farm, Prince George, emphasize studies on forage production and utilization in interior British Columbia native rangelands, as well as on forage crops grown from seeded pasture and for winter feeds. Basic studies on poisonous plants, bloat, and winterhardiness are also conducted. The staff utilize their expertise in chemistry, biochemistry, plant physiology, soil science, plant ecology, range management, forage agronomy, and animal science to provide knowledge and technology for those interested in animal production.

Only highlights of our 1981 research are reported. Detailed information can be obtained from the Director, Agriculture Canada, Range Research Station, 3015 Ord Road, Kamloops, B.C. V2B 8A9, or from the Superintendent, Agriculture Canada, Experimental Station, R.R. 8, RMD 6, Prince George, B.C. V2N 4M6.

J. D. McElgunn
Director

FORAGES

Growth and phenological development of rough fescue in interior British Columbia

Growth and phenological development of rough fescue (*Festuca scabrella*) in interior British Columbia have been documented for a 3-yr period. The plants began growing around mid-April and normally ceased growing in late June. Culm growth began in late May and ceased at approximately the time leaf growth ceased. However, leaf and culm elongation ceased before the plants reached their full weight. Rough fescue headed out between 14 May and 10 June. Seed shattering occurred between 13 July and 24 July. Seed head production per plant varied from year to year. Fall regrowth occurred in September one year, in October another year, and not at all another year.

Utilization of bluebunch wheatgrass by cattle and deer

Deer and cattle grazing in spring preferred bluebunch wheatgrass plants that had been defoliated the previous fall to those that had not. Deer selected burned plants in greater proportion than grazed plants. Fall grazing by cattle affected the distribution of deer, because deer displayed preference for the fall-grazed field after green growth exceeded the height of stubble.

Nitrogen fertilizer of crested wheatgrass

Three Chernozemic (Mollisol) soil sites with established stands of crested wheatgrass were fall-fertilized with N levels of 0, 25, 50, and 100 kg/ha and harvested for six successive years. The forage was analyzed for N, Ca, P, K, Mg, and digestible energy. Average dry matter (DM) yields for the sites were 343, 592, and 878 kg/ha, with increasing yields corresponding to increasing site elevations. Precipitation regimes of the sites were positively related to elevation. DM response was not significant at any N level or any year at the driest site, but it was significant at the N level of 100 kg/ha at the other two sites and at the N level of 50 kg/ha at the moistest site for three of the first 4 yr. Less N seemed to be required to satisfy the soils' N-immobilization capacity at the drier of these two sites. Average N-uptake efficiency increased from the driest (9%) to the moistest (29%) site. It decreased with the increasing N-application rate at the driest site (12–7%) but increased at the moistest site (12–32%). Prolonged grazing at the harvest stage by young steers could lead to deficiencies of N, P, and possibly Mg and K. Digestible energy (1974) increased with increasing dryness of site and increasing rate of N fertilization.

Seasonal threats of poisoning from saskatoon and chokecherry

The hydrogen cyanide (HCN) potentials of saskatoon (*Amelanchier alnifolia*) and chokecherry (*Prunus virginiana*) were analyzed from various sites every 2 wk from

March to September in 1979 and 1980. They were ground in dry ice and incubated with emulsin to release HCN, which was used to estimate the concentration of prunasin, a cyanogenic glycoside. Prunasin levels indicated that chokecherry foliage was very toxic at all stages of growth, but saskatoon foliage could be considered hazardous mainly during bloom. In woody tissue, the HCN potential was approximately the same for both species; its concentration exceeded the level required to produce acute signs of poisoning in cattle. The HCN potential increased in twigs during the dry year 1979, and this effect was greater in new growth of chokecherry as compared with saskatoon. Buds and flowers of both species showed higher prunasin levels than did the fruit. The results of this survey should provide a basis for predicting the potential toxicity of saskatoon and chokecherry to ruminants.

Coldhardiness studies

Saskatoon and sorghum have been used as study plants in freezing injury because the cells release hydrogen cyanide (HCN) when injured. This HCN can readily be detected in the frozen tissue.

A new method was developed that facilitates the release and determination of hydrogen cyanide from saskatoon tissue. Shrub parts are ground in dry ice and incubated for 1 h in a buffered solution containing hydrolytic enzymes. The incubation mixture is then analyzed directly, thereby eliminating the requirement for cyanide distillation or microdiffusion. The method is used to determine the cyanide potential in buds, leaves, twigs, and fruit of 24 saskatoon selections that are potentially suitable for commercial production. In agreement with previous studies, the results indicate that vegetative parts of saskatoon are potentially hazardous to ruminants, but that the fruit can be considered innocuous.

Cold-acclimated twigs of *Amelanchier alnifolia* Nutt. released less HCN at –4.5°C than nonacclimated twigs, following slow freezing to –25°C or rapid freezing to –78°C. Cold-acclimated twigs frozen slowly to –25°C released more HCN than cold-acclimated twigs frozen only to –4.5°C. Cold-acclimated twigs frozen slowly to –25°C and then rapidly to –78°C released less HCN at –4.5°C than cold-acclimated twigs frozen rapidly to –78°C. In general, K^+ efflux and the inability to reduce triphenyltetrazolium chloride following freezing and thawing paralleled HCN release at –4.5°C. Because low K^+ efflux and high triphenyltetrazolium chloride reduction are known to depend upon membrane integrity, the increased K^+ efflux and the decreased triphenyltetrazolium chloride reduction following freezing and thawing provide indirect evidence that HCN release at –4.5°C is a measure of membrane damage in frozen cells.

The influence of thawing on freeze-injured saskatoon twigs was evaluated by refreezing freeze–thawed twigs and comparing the HCN release at –5°C from these twigs to the HCN release at –5°C from twigs that had not been thawed. An effect of thawing depended on the physiological state of the twigs or on the freezing conditions. Manifestation of membrane injury does not have an absolute dependence on thawing and, thus, on membrance area expansion. Post-thaw temperature influences manifestation of injury, because twigs warmed to 30°C released more HCN than twigs warmed to 1°C when refrozen to –5°C.

Toxicity studies with timber milk vetch

In vitro and in vivo metabolic studies were conducted with bovine blood to determine decay rates for 3-nitropropanol (NPOH), a toxic forage constituent occurring in many *Astragalus* species. Methemoglobin (metHb) and plasma nitrite (NO_2) levels were concomitantly determined and early signs of poisoning were recorded. Subtle increases in heart and respiration rates, development of a placid, stupefied state, frothy salivation, and incoordination characterized early stages of intoxication. Animals with low decay rates for NPOH showed a gradual increase in the metHb and NO_2. When the decay rate was high, a rapid increase in metHb and NO_2 was observed. Acutely poisoned animals showed the highest levels of metHb and NO_2 but intermediate rates of decay for NPOH. When NPOH was incubated with bovine blood in vitro, NO_2 was not detected and metHb was not significantly altered, indicating that NPOH is not metabolized in bovine blood. A new method is described for determining NPOH in bovine blood.

Over a 2-yr period (1980–1981) rumen fluid was obtained from cattle on various diets to compare their effects on microbial metabolism of 3-nitropropanol (NPOH), the toxic

metabolite that occurs in certain species of the legume family. In both years, NPOH was degraded most rapidly ($P < 0.05$) when range diets contained Kentucky bluegrass (*Poa pratensis*). Pinegrass (*Calamagrostis rubescens*) range was associated with high rates of NPOH degradation (>200 μmol/L per hour) in 1980 but not in 1981. Feedlot, pasture, and bluebunch wheatgrass (*Agropyron spicatum*) diets showed lower rates of NPOH metabolism. An orchard grass diet resulted in high rates of metabolism in 1981. Rapid rates of nitrite reduction were correlated with the degradation of NPOH, thereby corroborating the detoxification of the aliphatic nitro group via nitrite to ammonia. The induction of NPOH metabolism by dietary components is considered and ruminal rates of NPOH metabolism are discussed in relation to forage quality. Preliminary results indicate that nitrate may serve as a substrate for inducing ruminal detoxification of nitrite and NPOH in cattle.

Of 33 pure strains of rumen bacteria from the Lethbridge laboratory collection, five degraded both 3-nitropropanol (NPOH) and 3-nitropropionic acid (NPA) under anaerobic conditions, and another five strains degraded only NPA. The NPA was metabolized at a faster rate than the NPOH by both pure cultures of rumen bacteria and mixed rumen microorganisms.

Nitrite was detected during the incubation of NPOH and NPA with resting cells, but not with growing cultures of active strains of rumen bacteria. Nitrite was metabolized much faster than the nitrotoxins by both pure cultures of rumen bacteria and mixed rumen microorganisms. The results suggest that the nitro moiety of NPA or NPOH is metabolized to inorganic nitrite which is reduced to ammonia by rumen microorganisms, thereby resulting in its detoxification.

PUBLICATIONS

Research

Majak W.; Cheng, K.-J. 1981. Identification of rumen bacteria that anaerobically degrade aliphatic nitrotoxin. Can. J. Microbiol. 17:646-650.

Stout, D. G. 1981. Calculation of protoplast freezing strain in multicellular plant tissues. Cryobiology 18:521-527.

Stout, D. G.; Brooke, B. M.; Majak, W.; Reaney, M. 1981. Influence of cold acclimation on membrane injury in frozen plant tissue. Plant Physiol. 68:248-251.

Miscellaneous

McLean, A. 1981. Treasures of Lac du Bois. Peerless Printers, Ltd. Kamloops, B.C.

Saanichton Research and Plant Quarantine Station

Sidney, British Columbia

PROFESSIONAL STAFF

Administration

J. M. Molnar, B.S.A., M.Sc., Ph.D.	Director
G. Blair	Administration Officer

Scientific Support

M. A. Watson,[1] B.A., M.Lib.	Librarian

Research

R. E. Harris, B.S.A., M.S.A., Ph.D.	Head of Section; Tissue culture
R. G. Atkinson, B.S.A., Ph.D.	Plant pathology—ornamentals
A. W. Chiko, B.Sc., M.S., Ph.D.	Viruses—ornamentals
C. J. French, B.Sc., Ph.D.	Plant physiology—woody ornamentals
H. Hartmann, B.Sc. (Agr.), M.Sc., Ph.D.	Plant pathology—vegetables
W. C. Lin, B.S., M.Sc., Ph.D.	Plant physiology—floriculture
J. P. L. Monette, B.Sc., Ph.D.	Plant physiology—tissue culture
N. V. Tonks, B.S.A., M.S.	Entomology
E. M. van Zinderen Bakker, B.Sc., M.Sc., Ph.D.	Plant physiology—vegetables

Plant Quarantine

R. Johnson,[2] B.S.A.	Head of Section; Grape viruses
D. Thompson,[3] B.Sc.	Tree fruit viruses

Departure

B. WARNER, B.S.A.	Plant quarantine

EXTENSION SERVICES[3]

B. WARNER, B.S.A.	Greenhouse and vegetable crops
M. S. BETTS, B.Sc. (Agr.), M.Sc.	Field crop specialist
D. P. ELLIOTT, B.Ed.	Greenhouse biological control

---

[1]Seconded from Libraries Division, Finance and Administration Branch.
[2]Food Production and Inspection Branch.
[3]British Columbia Ministry of Agriculture and Food.

INTRODUCTION

The Saanichton Research and Plant Quarantine Station has a dual responsibility. First, it is the ornamentals and greenhouse vegetable research center for British Columbia, and second, it is responsible for the national post entry quarantine program for Canada.

The Station's research programs are oriented to solving problems and giving direct service to the ornamentals and vegetable industry. Emphasis in research is being given to nutritional and physiological problems in floriculture, plant propagation, postrooting development of nursery plants, eradication of viruses, rapid multiplication of grapes and ornamentals by tissue culture, and control of pests and diseases in vegetables and ornamentals.

A new program was initiated in energy conservation in greenhouses. A new solar-heated greenhouse complex has recently been constructed at the Station, the result of a cooperative effort between the British Columbia Ministry of Agriculture and Food; the University of British Columbia, Department of Bio-Resource Engineering; and Agriculture Canada. In another new program, infrared heat was used for heating greenhouses, with considerable energy savings.

The quarantine program is responsible for testing for virus infection of all imported tree fruit, grape, and small fruit plant material that is not accompanied by an acceptable phytosanitary certificate, and for verifying the reliability of recognized foreign certification programs for fruit nursery stock by testing plant samples from imported commercial shipments for virus infection (audit program). Tests are conducted on promising selections from Canadian tree fruit and grape breeders to ensure that original releases to the industry are free from detectable viruses. We have established plantings of valuable virus-free fruits and grapes as a repository for the Canadian fruit industry and research programs.

Requests for information or publications should be addressed to the Saanichton Research and Plant Quarantine Station, Agriculture Canada, 8801 East Saanich Road, Sidney, B.C. V8L 1H3.

J. M. Molnar
Director

ORNAMENTALS

Minimum intensity of supplementary lighting required for growth acceleration of woody ornamentals

Night interruption (2200–0200 h) with incandescent lamps at low intensity (0.8 klx) promoted vegetative growth of *Ilex aquifolium* 'Pemberton'; *Magnolia stellata*; *Rhododendron* 'Anah kruschke', 'A. R. Whitney', and 'Floriade'; and *Thuja occidentalis* 'Smaragd'. The treatment had no effect on *Camellia* sp.; *Ilex aquifolium* 'Brethour', 'Pinto', 'Shortspra', and 'J. C. van Tol'; *Juniperus chinensis* 'Old Gold'; and *Thuja occidentalis* 'Pyramidalis'. Supplementary lighting with high-pressure sodium (HPS) lamps at high intensity (2.2, 3.3, 4.4, or 5.5 klx) for 16 h (0400–2000 h) promoted vegetative growth of *Camellia* sp.; *Ilex aquifolium* 'Brethour', 'Pinto', 'Shortspra', and 'J. C. van Tol'; *Juniperus chinensis* 'Old Gold'; *Rhododendron* 'Anah kruschke' and 'Floriade'; *Thuja occidentalis* 'Pyramidalis' and 'Smaragd'; *Ilex aquifolium* 'Pemberton'; and *Magnolia stellata*. However, this treatment had no effect on *Rhododendron* 'A. R. Whitney'. Light intensity (HPS at 2.2, 3.3, 4.4, 5.5 klx) had no quantitative relationship with growth of the first eight genotypes that responded positively with 16-h HPS lighting, but in the last four genotypes, maximum growth was obtained at the high light intensity (4.4 or 5.5 klx). Results indicated that optimal growth of woody ornamentals requires high-intensity supplementary lighting rather than low-intensity day-length extension, and that the necessary HPS intensities for growth acceleration varies with genotypes.

High-intensity supplementary lighting for *Gerbera* flowering

Daily 16-h (0400–2000 h) supplementary lighting with HPS lamps at high light intensity increased *Gerbera* production in raised soil beds when the soil was heated to 24°C but

had no effect at a 16°C soil temperature. The HPS lighting effect on flower production was apparent during the winter months (mid-October to early February), but production from April to August was not affected. In comparison, with potted *Gerbera* grown under natural daylight during the same winter months, HPS lighting increased the number of flower stems by 12%, but night interruption with incandescent light at low light intensity from 2200–0200 h reduced flower production by 15%. It appeared that HPS lighting for 16 h daily might have been too long, because short days (black cloth 1600–0800 h) increased production by 13% over natural daylight.

Rooting woody plant shoots produced in vitro

The key to consistent rooting of proliferated shoots of woody plants is to harvest the shoots after the cytokinin content of the proliferation media has been reduced and before the shoot tissue begins to harden. Reducing the NH_4 content of the proliferation media increased subsequent rooting of the shoots of *Pieris* and *Photinia*, whereas increasing the NO_3 tended to improve rooting. Maintaining the explants at low light intensities (<1000 lx) or in complete darkness for 5–10 days increased rooting of *Photinia* but had only a marginal effect on *Amelanchier*. Liquid Murashige minimal organic medium at one-quarter strength was found to be a better rooting medium than stronger media or media solidified with agar. Shoots of *Photinia* rooted better in complete darkness or low light (<1000 lx) than at 2000 lx. The amount of auxin in the rooting medium was not critical, ranging from 0.3 to 1.5 mg/L of indoleacetic acid and from 0.3 to 3.0 mg/L of indolebutyric acid in the species studied.

Soil drenches for black vine weevil larvae

Counts of black vine weevil larvae on container-grown ornamentals treated with insecticidal soil drenches were as follows (grubs per pot): untreated, 4.65; acephate 75% S.P. with an a.i. level of 1 g/L, 0.1; malathion 50% E.C. with an a.i. level of 1.2 g, 0.46; permethrin 50% E.C. with an a.i. level of 0.1 g, 0.88; carbofuran 4.8 F with an a.i. level of 0.3 g, 0.25. These results and those of previous trials indicate that several materials are effective when applied early to young larvae. The best control was obtained with two treatments applied 4–6 wk apart during the peak egg-laying period.

***Phytophthora* root rot of Lawson cypress**

Metalaxyl, one of a new class of acylalanine systemic fungicides, shows long-term residual action at low concentrations when applied as drenches to control *Phytophthora* root diseases. Lawson cypress var. *allumii* transplanted to pots of soil infested with *P. cinnamomi*, and drenched with metalaxyl 5 W.P. at 400 or 800 mg/L once before planting (preplant) and again after planting (postplant), remained healthy until discarded after 18 mo. These rates were not effective when both drenches were applied after planting. When the rate was increased to 1.8 g/L, however, either schedule of the dual-drench treatment effectively prevented root rot for the 8-mo experimental period.

Phytophthora* root rot of *Gerbera

At the Saanichton Research and Plant Quarantine Station, gerbera plants, propagated from imported crown-root pieces, wilted and were found to be infected with *Phytophthora cryptogea*. When healthy gerbera plants were transplanted to pots of soil or soilless medium infested with *P. cryptogea* and drenched twice with metalaxyl at 1 g/L, once before and again after planting, or only after planting, all plants remained healthy for the 4.5-mo experiment. Aliette 50 W.P. at 3 g/L and Truban 30 W.P. 4 g/L were ineffective, whereas Chevron 9940 50 W.P. at 2 g/L was only partially effective.

Virus diseases

The identities or properties of viruses transmitted mechanically from ornamentals with various leaf symptoms to herbaceous indicator plants were as follows.

Daphne. Alfalfa mosaic virus and tomato ringspot virus (TomRSV) were isolated from *D. odora* and *D. mezereum*, respectively. The host range of an unidentified spherical virus (ca. 30 nm diam.) from *D. odora* was similar to that of TomRSV from *D. mezereum*, and both viruses were seed transmitted in *Chenopodium quinoa*. However, the unidentified virus did not react with TomRSV antiserum or with antiserum for each of 10 other nepoviruses. The normal lengths of flexuous rod-shaped particles of three virus isolates from *D. mezereum*, each tentatively thought

to be *Daphne* virus Y, were 768, 783, and 783 mm.

Euphorbia pulcherrima. Poinsettia mosaic virus was isolated from plants of two cultivars (Brilliant and Dark Red Hegg) grown from cuttings imported from California. Infectivity assays indicated that all these plants were virus infected.

Begonia tuberhybrida. Preliminary observations suggested that many different selections of tuberous begonia were infected with a small spherical virus.

SMALL FRUITS

Rooting shoots of saskatoon (*Amelanchier alnifolia*) produced in vitro

The key to consistent rooting of proliferated shoots of saskatoon is to harvest the shoots after the cytokinin has been reduced but before the tissue hardens. When harvested at the right stage, more than 70% of the shoots root in 21 days on one-quarter-strength Murashige's minimal organic medium containing 0.3–3.0 mg/L indolebutyric acid (IBA) or 0.6–1.0 mg/L indoleacetic acid, or after a 54-h dip in media containing 5 mg/L IBA.

Postrooting growth of saskatoon (*Amelanchier alnifolia*) shoots produced in vitro

Postrooting dormancy is a major problem in vegetative propagation of saskatoons. New top growth was apparent days after spraying with an aqueous solution containing a spreader and gibberellic acid (GA_3) at 1 mg/L, but further root development was suppressed. The adverse effect on rooting can be reduced and possibly eliminated by reducing the GA_3 concentration or by delaying the spray application. Work to determine the optimum concentration is continuing.

VEGETABLES

Effect of supplementary light, soil, and air temperatures on greenhouse tomatoes

Vendor tomatoes were seeded on 23 December 1980 and 9 January 1981; the later-seeded plants were supplied with supplementary HPS light for 16 h/day for 29 days. There was no difference in the total yields between the treatments, but the early yield was higher in the plants that had been exposed to the HPS light. An average minimum air temperature of 13°C produced a higher total yield of tomatoe than an average nighttime air temperature of 10°C but the average fruit size was greater with the lower temperature. These results confirm those of 1980 that 3 wk can be saved in the propagation stage of tomatoes through the use of HPS lights, thus reducing heating costs at the coldest time of the year.

Overwintering cauliflower

Cauliflower cultivars were planted on 28 August and 11 and 26 September. Harvesting started on 18 February and was completed 3 June, with most cultivars having a harvest period of 4 wk. Cultivars planted on the third planting date produced smaller heads than those planted on the other two dates. Average head size varied from 203 to 745 g for the first planting with an overall average of 500 g. The second planting date produced an average head size of 510 g (292–762) and the third only 339 g (210–531).

Extending the growing season of vegetables with low plastic tunnels

Zucchini was seeded on 9 March and transplanted to a prepared field on 6 April. Two different cover types (clear solid and Xiro-perforated) as well as no cover, and two mulch types (clear and black) as well as no mulch, were used. All combinations of these treatments were tested. The plants without a plastic cover had to be replaced because of frost on 13 April. Although no further frost occurred, the temperatures were low enough to require most of the outside plants to be replaced again on 12 May. No plants were replaced in the clear plastic or Xiro tunnels. No differences were found between the three mulch types when compared on the basis of yield, earliness, or fruit size, but there were significant differences between the tunnels. Although the average fruit weight was the same, the uncovered treatment produced significantly less fruit for harvest, especially for the early harvest, which was reduced by more than 70%. The results of the study show that the use of low plastic tunnels may advance the growing season for zucchini by 1 mo and significantly increase the early yields.

Solar-heated greenhouse

The experimental solar shed, which is one-half of a conventional glass-covered gable greenhouse with an insulated north wall, and the experimental control gable greenhouse have been erected and are in full operation. Performance of the solar shed to date indicates that the thermal-curtain collection system can absorb and build up more heat than was originally expected. However, the solar fan speed must be increased in order that this heat can be stored, as airflow rates through the rock storage have been lower than that which was forecasted. Based on a projected 40% saving in fuel, the solar-heating system will pay for itself in approximately 6 yr. However, to make the system practical, ways must be devised to reduce the construction costs.

Powdery mildew of greenhouse cucumbers—Control by fungicides

Effects of fungicidal sprays on powdery mildew were quantitatively assessed by assigning a numerical rating of 1–5 (in order of increasing number of lesions) to each leaf, from which an average "disease index" was obtained for each treatment. On the susceptible var. *greenspot* final disease ratings after a single spray indicated that Benlate 50 W.P. at 1.25 g/L failed to reduce severity of powdery mildew, but that CGA-64251 10 W.P. at 312.5 g/L and Milgo E at 0.36 ml/L reduced disease severity to about one-half that in unsprayed check plants. Two sprays of Benlate at 1.25 g/L, 14 days apart, again failed to control powdery mildew on the susceptible var. *corona*, whereas CGA-64251 at 625 mg/L and Milgo E at 0.36 ml/L suppressed the disease so much that a final rating was impossible on the obscure lesions.

Powdery mildew of greenhouse cucumbers—Reaction of cultivars

Long English cucumbers resistant or tolerant to powdery mildew were grown among susceptible varieties, and disease incidence was rated numerically 1.5 mo after plants at the four-leaf stage were exposed to mildew. The susceptible cultivars Farbio and Renova were severely infected, whereas the disease rating for the tolerant cultivar Fidelio was only about one-third that of the susceptible ones. The disease index of cultivars Bella and Silvia (Asunta) was higher than that of Fidelio but still only about one-half that in the susceptible cultivars.

Infrared heating in greenhouses

The infrared heating system gave a cost saving of 47% but the crop was delayed. This delay would make the system unacceptable for the growers. Also, the heat did not distribute evenly through the tall tomato crop, because the upper leaves "shaded" the lower leaves from the heat source.

PLANT QUARANTINE

The virus-tested repository of grapevines, tree fruits, and related ornamental varieties was increased by 51 clones to a total of 847. Distribution from the repository totaled 45 000 buds from 13 342 tree fruit scions and 3255 grape cuttings. Most shipments were made within Canada but requests were received from the United States, New Zealand, and Kenya.

There were 109 new submissions for indexing, including promising peach, apricot, and nectarine cultivars from Ontario, grape selections from British Columbia, and ornamental laurels for the British Columbia nursery trade.

PUBLICATIONS

Research

Everson, P.; Tonks, N. V. 1981. The effect of temperature on the toxicity of several pesticides to *Phytoseiulus persimilis* (Acarina: Phytoseiidae) *Tetranychus urticae* (Acarina: Tetranychidae). Can. Entomol. 113:333-336.

French, C. J.; Mommsen, T. P.; Hochachka, P. W. 1981. Amino acid utilisation in isolated hepatocytes from rainbow trout. Eur. J. Biochem. 113:311-317.

Kay, W. W.; Buckley, J. T.; Ishiguro, E. E.; Phipps, B. M.; Monette, J. P. L.; Trust, T. J. 1981. Purification and disposition of a surface protein associated with virulence of *Aeromonas salmonicida*. J. Bacteriol. 147(3):1077-1084.

Lin, W. C.; Molnar, J. M. 1982. Effects of CO_2 mist and high intensity supplementary lighting on propagation of selected woody ornamentals. Can. J. Plant Sci. 61:965-969.

Van Zinderen Bakker, E. M. 1981. The occurrence and geochemistry of vanadium in Canada. Pages 1-94 *in* Effect of vanadium in the Canadian environment. Nat. Res. Counc. Can. Publ. 18132.

Miscellaneous

Adamson, R. M.; Maas, E. F. 1981. Soilless culture of seedless greenhouse cucumbers and sequence cropping. Agric. Can. Publ. 1725. 21 pp.

Costello, R. A.; Elliott, D. P.; Tonks, N. V. 1981. Integrated control of mites and whiteflies in greenhouses. B.C. Minist. Agric. Food Bull. 15 pp.

Molnar, J. M. 1981. Research Highlights. Pages 20-29 *in* Les floralies internationales de Montreal colloques scientifiques. No. 6, Protection des vegetaux.

Research Station
Summerland, British Columbia

PROFESSIONAL STAFF

G. C. Russell, B.S., M.S., Ph.D.	Director
H. F. Madsen, B.A., Ph.D.	Associate Director
L. C. Godfrey, B.Sc.	Head, Administration
V. B. Madsen,[1] B.A., M.L.S.	Librarian

Entomology–Plant Pathology

R. D. McMullen, B.Sc., M.Sc., Ph.D.	Head of Section; Bionomics of pear psylla
F. L. Banham, B.A.	Stone fruit insects
A. J. Hansen, Dip.Agr., M.Sc., Ph.D.	Tree fruit virus diseases
H. F. Madsen, B.A., Ph.D.	Integrated control
W. J. McPhee, B.A., M.Sc., Ph.D.	Tree fruit fungus diseases
J. T. Slykhuis, B.S.A., M.Sc., Ph.D.	Stone fruit virus diseases
R. S. Utkhede, B.Sc., M.Sc., Ph.D.	Tree fruit fungus diseases
J. Vakenti, B.Sc., M.Sc.	Orchard mite control

Food Processing

J. A. Kitson, B.A., M.S.	Head of Section; Engineering new products
D. B. Cumming, B.S.A., M.Sc., Ph.D.	Food technology
D. R. MacGregor, B.S.A., M.S., Ph.D.	Product development and microbiology
G. E. Strachan, B.S.A., M.Sc.	Enology, food technology

Pomology and Viticulture

E. J. Hogue, B.S.A., M.S., Ph.D.	Head of Section; Herbicides, vegetation management, nutrition
L. G. Denby, B.S.A., M.S.A.	Viticulture, grape breeding
W. D. Lane, B.Sc. (Agr.), M.Sc., Ph.D.	Apple and cherry breeding

N. E. Looney,[2] B.S., M.S., Ph.D.	Pomology, plant physiology, growth regulators
M. Meheriuk, B.Sc., B.Ed., M.Sc., Ph.D.	Fruit storage and biochemistry
H. A. Quamme, B.S.A., M.Sc., Ph.D.	Orchard management, hardiness

Soil Science and Agricultural Engineering

D. S. Stevenson, B.S.A., M.S., Ph.D.	Head of Section; Soil moisture
A. P. Gaunce, B.Sc., M.Sc., Ph.D.	Pesticide and environmental chemistry
P. B. Hoyt, B.Sc., M.S., Ph.D.	Soil chemistry and management
A. L. Moyls, B.A.Sc., M.S., Ph.D.	Agricultural equipment—development and assessment
G. H. Neilsen, B.Sc., M.Sc., Ph.D.	Soil fertility and plant nutrition
P. Parchomchuk,[3] B.A.Sc., M.S.	Agricultural equipment—development and assessment

Departures

J. Vakenti Resigned November 1981	Orchard mite control
J. A. Kitson Retired December 1981	Head of Section; Engineering new products

VISITING SCIENTISTS

O. L. Lau,[4] B.S., M.S., Ph.D.	Pomology, viticulture
C. H. Klaren,[5] B.Sc., M.Sc., Ph.D.	Pomology, viticulture

[1]Seconded from Libraries Division, Finance and Administration Branch.
[2]On transfer of work to East Malling Research Station, Maidstone, Kent, England, from September 1981 to September 1982.
[3]On Canadian International Development Agency (CIDA) assignment from October 1979 to March 1982.
[4]British Columbia Tree Fruits Research Associate since July 1976.
[5]Natural Sciences and Engineering Research Council Postdoctorate fellow from November 1980 to November 1982.

INTRODUCTION

The Research Station, Summerland, is the center for tree fruit research in Western Canada and also has a major role in research with grapes. Only a limited portion of the total research is reported here, but the purpose is to indicate the scope of the research and the diversity of results obtained. Anyone wishing further information is encouraged to contact individual scientists at Agriculture Canada, Research Station, Summerland, B.C. V0H 1Z0.

A number of staff members have been involved in international studies. Dr. H. F. Madsen returned in July after a year in Australia studying the management of codling moth in apple orchards. Mr. J. A. Kitson continued to work with the Canadian International Development Agency in Colombia and visited Mainland China at the invitation of the Chinese Government to observe food processing development and suggest ways to assist the program. Dr. D. S. Stevenson was invited to visit Israel in November to observe irrigation practices in that country and to recommend programs to improve efficiency of water use. Dr. N. E. Looney left Summerland in September on a 1-yr transfer of work to the East Malling Research Station, England, to study growth regulators on apple. Dr. R. D. McMullen led a team of entomologists to Japan for a joint Canada–Japan workshop on integrated pest management of apple and pear pests.

In September, a group of Japanese Ministry of Agriculture officials visited the Summerland Station to observe fumigation techniques for disinfecting cherries containing codling moth larvae and to review procedures that may allow the export of British Columbia cherries to Japan in 1982.

Products named in this report are not necessarily recommended for use nor is there an implication that they have preference over other products that may be used for the same purpose.

G. C. Russell
Director

ENTOMOLOGY–PLANT PATHOLOGY

A possible biological control agent for control of crown rot of apple

Five bacteria isolated from soil by dilution plate and selective medium techniques produced diffusible antibiotics antagonistic to the growth of *Phytophthora cactorum*, the causal agent of crown rot of apple. The growth of bacterial isolate B8, which showed the greatest degree of inhibition of *P. cactorum*, was not significantly affected on corn meal agar containing mancozeb at 100 mg/kg or Aliette (May and Baker Canada Inc.) at 400 mg/kg but Ridomil (Ciba-Geigy Canada Ltd.) at 50 mg/kg significantly increased its growth. In contrast, the mycelial growth of *P. cactorum* on corn meal agar was completely inhibited by mancozeb and Ridomil at 50 mg/kg and Aliette at 600 mg/kg.

Effect of Ribavirin on sap-transmissible viruses

Ribavirin (Viratek Inc.), a quanosine analogue, was previously shown to be an effective inhibitor of apple chlorotic leafspot virus multiplication. This finding led to the expectation that similar results could be obtained with other viruses. This hypothesis was tested with eight other viruses: grape fan leaf virus, apple stem grooving virus, an unidentified virus from sweet cherry, lilac ringspot virus, cherry leafroll virus, and prunus necrotic ringspot virus, all in *Chenopodium quinoa*; guar symptomless virus in guar; and potato X virus in *Gomphrena globosa*. The infected plants were sprayed with Ribavirin at 500 mg/kg daily for 10 days commencing 16 h after inoculation. Apple chlorotic leafspot virus in *C. quinoa* was similarly treated for comparison. Inhibition of virus multiplication was complete with apple chlorotic leafspot, but only partial with potato X and not at all with the seven other viruses.

Transmission of little cherry disease by apple mealybug

Previously, evidence that the apple mealybug, *Phenacoccus aceris* (Signoret), was capable of transmitting little cherry disease was restricted to experiments where evidence of transmission was the expression of early senescence red leaf symptoms on small non-fruiting Sam variety trees. Bud grafts taken from the small test trees that showed the red leaf symptom and grafted onto mature fruiting Lambert variety trees resulted in the expression of little cherry disease symtoms on fruit. In 1981, three out of three mature fruiting Lambert variety trees that were inoculated via low numbers (10–25) of infective mealybugs in August 1979 exhibited severe fruit symptoms of little cherry disease. Also in 1981, two out of two mature fruiting Lambert variety trees that were inoculated in July 1980 with large numbers of infective mealybugs, approximately 500 per tree, developed severe fruit symptoms. These results afford conclusive proof that the apple mealybug is a vector of little cherry disease.

Brown rot on sweet cherries

It was found that during the late summer and autumn, *Spicaria* spp. colonized unharvested sweet cherries and completely utilized the fleshy part of the fruit. By the following spring only shriveled pits covered with masses of *Spicaria* spores remained. Even in orchards where 60–70% of the unharvested fruit clusters were infected with brown rot, 100% of the fruit was completely colonized by *Spicaria*. This effectively eliminated the brown rot mummified fruit as a source of brown rot inoculum in the spring and resulted in a much depressed infection pressure. *Spicaria* spp. did not efficiently colonize brown rot infected fruit of peach, apricot, plum, and sour cherry.

Control of pear psylla

In screening trials of new insecticides for control of pear psylla, SN72129 (Noram Chemicals) was found to have an excellent degree of selective toxicity, providing good control of pear psylla at 0.85–1.7 kg/ha without suppressing populations of predaceous insects, particularly of the families Miridae and Anthocoridae. In comparison, the synthetic pyrethroid insecticides cypermethrin and deltamethrin provided excellent kill of pear psylla at an active ingredient (a.i.) level of 100 and 20 g/ha, respectively, but almost entirely eliminated predaceous species. Multiple treatments were required in plots sprayed with the synthetic pyrethroids to maintain an adequate degree of control because of the elimination of natural predators, whereas a single treatment with SN72129 gave adequate control.

Control of peach twig borer

Damage to peach fruit at harvest by larvae of the peach twig borer was eliminated by one summer spray application of deltamethrin 2.5 EC with an a.i. level of 10 g/ha or by a pink bud stage spray followed by a summer spray application of deltamethrin 2.5 EC with an a.i. level of 10 g/ha or azinphos-methyl 50 WP with an a.i. level of 1.4 kg/ha. A new insecticidal compound, CGA73102 (Ciba-Geigy Ltd.), with an a.i. level of 30 g/ha applied in the summer, or at the pink bud stage and in the summer, was slightly less effective. The summer sprays were applied 10 days after each sex pheromone trap captured an average of two first-brood male moths a week.

Contol of peach tree borer

Two sprays of deltamethrin 2.5 EC with an a.i. level of 1.0 g/100 L or fenvalerate 30 EC with an a.i. level of 5.0 g/100 L applied by a hand gun sprayer to the trunks of peach trees, 0.62 L per trunk provided excellent control of peach tree borer. Two sprays of permethrin 25 WP with an a.i. level of 5.0 g were less effective but superior to two sprays of endosulfan 50 WP with an a.i. level of 75 g/100 L. The sprays were applied 1 wk after the first male moths were captured in sex pheromone traps and 4 wk later during peak moth emergence.

FOOD PROCESSING

Improved wine yeast for the fermentation of red wines from French hybrid grapes

During 1979–1980 all the yeasts of the collection at the Summerland Research Station were evaluated for their fermentation properties during winemaking. Initial screening was based on the ability to produce a wine having appropriate aroma and flavor, and the ability to ferment to dryness in a reasonable period. Further evaluations were on the basis of freedom from hydrogen sulfide production, lack of foam, rapid sedimentation at the end

of fermentation, and speed of fermentation. Strain Y5 from the University of Guelph collection was evaluated as superior to the commercial strains tested and was used during the 1980 and 1981 crushes for our experimental red wines. Fermentations using this strain had a mild aroma, seldom had hydrogen sulfide, fermented rapidly to dryness at 20°C, had little or no foam, and rapidly formed a firm sediment at the end of fermentation. The strain was previously used for experimental single-cell protein production and was originally isolated as a wild-type contaminant from a commercial Canadian white sparkling wine.

Fruit packed in the retort pouch

As a preliminary step toward the design of a processing system suitable for acid food products packed in retort pouches, a series of fruit packs was undertaken. Sweet cherries, peaches, and apricots were "hot filled" into 160 × 230 mm trilaminate pouches, sealed, and given a very short process (1 min) in boiling water in order to ensure that the seal area received a proper heat treatment. Results of storage trials thus far indicated no spoilage problems of a nature to be expected from acid fruit packed in a sugar syrup. Typically, pouches were filled with 80% fruit–20% syrup (40% soluble solids). Indications are that design of a suitable system for processing acid products would be a worthwhile undertaking that could provide a relatively simple "low cost" method of processing such foods in the retort pouch.

Calorie-reduced jams and jellies for home preparation

A series of 18 formulas for berry and tree fruit jams with reduced calorie content has been developed. Normally, consumers do not have access to the ingredients used by processors when making low-calorie products such as jams and jellies. The formulas that have been developed are intended for home preparation and utilize thickeners and natural and artificial sweeteners that are readily available to consumers. Quality of the various products was carefully screened prior to final preparation of a recipe book. Performance in the areas of storage, flavor, color, and texture were all examined prior to final selection. The recipe book is now available to the public through the Summerland Station.

Celery juice from trim waste

A relatively large portion of the celery plant is lost in the trimming operation applied prior to fresh marketing of celery. Volumes of celery waste in the Fraser Valley currently reach 18 000 kg/day during the production season (July–November). A process by which a high-quality clarified and debittered celery juice could be produced was worked out by H. Buttkus and reported in 1978. Scale-up and commercialization of the process have recently been undertaken. Two separate processors have produced quantities of juice on a trial basis, using the Buttkus recommendations modified to suit existing systems. It has been demonstrated that a high-yielding (80–85%) juice of pleasant flavor and good storage stability (acidified and frozen) can be produced. When mixed with tomato juice, added celery juice to a 20% level gave a very pleasant vegetable juice combination.

Vacuum aroma concentration

Strawberry and banana essences have been successfully concentrated in the small-scale CAVECS (Canada Agriculture Vacuum Essence Concentration System) unit and a full-scale run on banana essence is planned. High-quality aroma concentrates of both these products were provided to potential licensees. Concentrate strengths ranged from 20 000- to 40 000-fold, depending on feed material composition. Further tests are planned with a water-soluble citrus aroma to determine if a satisfactory concentrate can be made from this relatively unstable product. All commercial testing of the vacuum aroma concentration system is now subject to confidentiality agreements between Canadian Patents and Development Ltd. and interested processors.

Raspberry and strawberry products

Extraction processes have been developed and data have been provided on potential yields. Strawberry gave a yield of 90% juice on a single pressing. Pectinase treatment was essential to achieve a reasonable yield from strawberry. Raspberry, with a repressing, gave a yield of 92% juice. Pectinase treatment did not affect yield significantly from raspberry. Seventy-two Brix concentrates and palatable nectars were made from both fruits. Storage tests are being conducted. Color loss was rapid in strawberry products stored at room temperature and above.

POMOLOGY AND VITICULTURE

Some growth regulator and cluster thinning effects on de Chaunac grapes

Prebloom thinning of de Chaunac grapes to one or two proximal flower clusters per fruitful shoot generally improved berry quality in the year of treatment and increased vine yields in the subsequent year. Yield reduction in the year of thinning was minimized by small increases in berry set and berry size. Overall, vines thinned for three consecutive years yielded about 18% more sugar than comparable unthinned vines. However, in the second of the three seasons, shoots thinned to a single proximal cluster exhibited poorer set on that cluster than when two clusters remained. This and other observations led to the conclusion that within-shoot competition was less critical than expected and that a general reduction in crop load may be as effective as detailed thinning.

Chlormequat (CCC) treatment increased berry set on thinned and unthinned vines but reduced berry size (weight) and juice quality. Conversely, gibberellic acid (GA_3) reduced berry set, increased berry weight, and improved juice quality. GA_3 reduced juice acidity in one season and increased juice soluble solids in another. Benzyladenine applied with or without GA_3 proved to be without effect.

Anjou pear tree training experiment

Anjou pears on seedling Bartlett rootstocks were planted in 1974, at 2.44 × 4.88 m spacing to test five training methods on precocity and long-term performance. Treatments were regular pruning; regular pruning plus wooden spreaders to increase branch angles; trees planted at 45° angles; regular pruning with branches tied down to form a spindle; trees cut back to 30 cm at planting, and subsequent growth selected and pruned to form double-armed trees with branches at 45° angles to form a candelabra-shaped hedgerow tree.

After 8 yr in the orchard, the cumulative yields of the angle-planted trees and the spindle-trained trees were not significantly different from each other, being 53.7 and 55.9 t/ha, respectively. These yields were more than twice those of trees pruned in the regular manner with branches spread (26 t), and of trees with two-arm candelabra training (24.9 t), and three times greater than yields of trees in the check treatment, regular pruning with no spreaders (17.3 t). It appears, however, that certain of the pruning innovations, especially the two-arm candelabra, are not likely to prove practical or to lead to the formation of long-lived trees.

Effect of diphenylamine on uptake of calcium in Spartan apples

Spartan apples were dipped in $CaCl_2$ and diphenylamine (DPA) solutions to determine whether DPA enhanced the uptake of calcium. Analysis of the tissue showed that calcium values were not significantly different in apples dipped in the $CaCl_2$ solution than in apples dipped in $CaCl_2$ and DPA solutions. Considerable injury was observed on Spartan apples dipped in a $Ca(NO_3)_2$ and DPA solution. A white crystalline salt was evident on the skin and injury occurred immediately below the salt deposit. It would appear that an insoluble form of calcium had resulted from the combination used.

Evaluation of pears on clonal rootstock

Swiss Bartlett was evaluated on clonal rootstocks of Old Home Farmingdale (OHF-34, -51, -87, -130, -230, and -515), Angers and Provence Quince, and Old Home and Bartlett seedlings. All rootstocks were planted in 1974 at 2.4 m × 4.8 m.

Cumulative marketable yields from 1974 to 1980 showed OHF-87 to be the most productive, followed by OHF-34, -69, and -15. Potential tree size as indicated by trunk cross-sectional area was largest for OHF-34 and -515, followed by OHF -87 and -69. Efficiency derived from yield divided by trunk area was highest for Angers Quince and slightly less for OHF-87; Provence Quince was in third place. Both quinces, however, suffered from winter injury at the crown. Trees of OHF-51 were winter-killed.

Rootstock tissue cultures

Shoot cultures of five apple cultivars, M.27, M.9, M.26, M.111, and Macspur, a strain of McIntosh, were established in vitro and their response to different concentrations of cytokinin (benzyladenine, BA) and auxin (naphtheleneacetic acid, NAA) measured. At the three BA concentrations tested (1.0, 5.0, and 10 μM) cultivars differed in the number of shoots produced and in their requirements for BA for optimum shoot production. M.27

produced the most shoots, followed by Macspur, M.9, and M.26. The best concentration of BA for shoot production was 5.0 μM for Macspur and M.26, but slightly higher for M.27 and M.9. Rooting response was tested at NAA concentrations of 0.1, 0.33, 1.0, 3.3, 10, and 33 μM. The range of concentrations in which rootstock cultivars rooted was broader than for the scion cultivar Macspur, and the percent rooting of rootstocks (about 85%) was higher than Macspur (58%). The most rooting occurred at 1.0 or 3.3 μM NAA. M.9 produced callus, which prevented rooting, when chronically exposed to NAA, so a procedure of acute treatment was used. This allowed root initials to form but avoided callogenesis.

Breeding green apples

Crosses have been made for years with the objective of obtaining a Granny Smith-type apple and in 1982 several good candidates described here were selected for propagation.

8M-31-13. Fruit dark green with some blush, mature 10 September, regular in shape, 7.5 cm in diameter, juicy, with good texture and undistinguished flavor; tree good for cropping.

8C-15-35. Fruit light green with dark lenticels, mature 10 September, moderately attractive, sweet, juicy, up to 7.5 cm in diameter; tree productive, with a spurry growth habit.

8S-21-19. Fruit green with a yellow ground color and some blush, mature 10 September, mild in flavor, low in acid, 7 cm in diameter, good for storing.

8C-1-54. Fruit light green without any blush, mature 7 September, somewhat irregular, attractive, good in taste, juicy; tree productive, spurry.

8C-1-20. Fruit dark green, similar to Granny Smith, mature 4 September, 6.5 cm in diameter, firm with white flesh but poor in taste; tree productive.

SOIL SCIENCE AND AGRICULTURAL ENGINEERING

Orchard Ca, Mg, and K

Ca, Mg, and K were measured in soil, leaf, and fruit samples from 48 Starkrimson Red Delicious and 48 Summerland Red McIntosh apple trees located in 16 Okanagan orchards from Osoyoos to Vernon in 1979–1980. The relationship Ca > Mg > K was generally found in local soils, although for 9 sites soil Mg content comprised 5–10% of exchangeable bases and could be considered low, and for 15 sites soil K exceeded 10% of exchangeable bases and could be considered relatively high. The Delicious trees accumulated higher leaf Ca, Mg, and K and higher fruit Ca and K compared to McIntosh on a similar range of soils. A significant correlation between McIntosh leaf and soil Mg (expressed as a percentage of exchangeable bases), was found in the 2 yr of the study. No direct positive plant–soil relationships were found for Ca or K. Significant negative correlations were measured both years between soil Ca (expressed as a percentage of bases) and leaf Mg for both cultivars, and between leaf Ca and K and between leaf K and Mg for Delicious. The results emphasized the importance of balanced orchard cation nutrition, particularly with respect to local soil Mg.

Effects of soil pH in Delicious orchards

Ten to 15 yr-old Starkrimson Delicious apple trees on seedling rootstock were sampled in several orchards selected for uniformly low soil pH (<5.0), medium soil pH, and high soil pH (6.5–7.3). Twenty- to 25-yr-old Harrold Red Delicious were sampled in 18 orchards that had low, medium, and high pH within each orchard. Soils with low pH had higher exchangeable Mn and low exchangeable Ca. Exchangeable soil Mg and K levels were not significantly related to soil pH. Higher leaf Mn was the main plant nutrient response with both Harrold Red and Starkrimson trees, exhibiting significantly increased leaf Mn on soils with low pH. Significantly decreased mid-terminal leaf Ca and increased Fe were also measured on the younger Starkrimson trees at low soil pH. Soil pH had no direct effect on fruit firmness, soluble solids, juice acidity, or flesh Ca, Mg, and K contents. Post-storage fruit-quality problems were primarily surface scald and not related to differences in soil pH. Incidence of internal browning was, however, related to low flesh Ca content.

Calcium infiltration

Tests on the 1980 apple crop demonstrated that immersing the fruit in a 4% $CaCl_2$ solution at 7031 kg/m³ for 3 min was sufficient to raise the calcium content of the fruit to acceptable levels to prevent storage breakdown. Tests in 1981 included a quicker dip treatment (1 min) as well as tests on pears and on prevention of spore infection. Also, a high-volume fluid spray/cascade was used in an attempt to wet the fruit before applying pressure. This used much less fluid than a dip and obviated the need for a submerged tunnel in a packinghouse design. A quick-acting wedge door was tested and it seems to be a good way to rapidly seal off the pressure chamber.

Fruit drying

A second commercial unit for making fruit leathers has been constructed and is currently undergoing airflow tests at the Station. A novel approach of continuously moving guide vanes was employed in an attempt to distribute the airflow more uniformly over all the puree trays. The object was to obtain a uniformly dried product in all parts of the tray at the end of the drying period.

Tree injection

A device for injecting nutrient solutions into fruit trees was constructed. It utilized hollow screws, pressure lines, and a hydraulic cylinder that forced fluid into the trees at 140 614 kg/m³. A typical time was 5 min to inject 1.5 L of calcium solution, but this time varied widely, depending on solution, tree type, tree size, and weather. Fluid injected in the trunk traveled up to the fruit and down to the roots. The solution did not move to all branches immediately, but was expected to redistribute throughout the tree during the growing season. Analysis of the fruit has yet to be carried out to determine the effect on calcium concentration. High concentrations caused leaf burning and greatly reduced yield.

Fumigation of cherries for export markets

Low-temperature fumigation of cherries with methyl bromide (64 g/m³ for 2 h at 12°) killed all codling moth larvae; 72 g/m³ was required for complete mortality of eggs. Methyl bromide residues were within accepted tolerances, and fruit quality was unaffected by either dosage. The fumigation procedures were demonstrated to Japanese plant protection officials in anticipation of exporting cherries to Japan in 1982.

Nitrogen returns with drainage water in lysimeters

For the year 1 October 1980–30 September 1981, nitrogen retrieval in drainage water from a sandy loam soil in lysimeters was 107 and 101% under clean cultivation, and 28 and 67% under grass cover from nitrogen applications of 0.11 and 0.22 kg/tree.

In these lysimeters, each one containing a single Macspur apple tree, the irrigation for 1981 was at 75% of normal for the area and soil type, up from 60% of normal in 1980. The effect of the grass cover crop as opposed to clean cultivation is both obvious and dramatic and agrees with results of previous years. This despite no observable difference in the return flow of water between the two soil surface treatments (29 and 27% for grass and clean cultivated) during 1980–1981.

Although the grass shows a strong tendency to immobilize N at least for a time, there is evidence, as in previous years, that at a certain level of N application a breakthrough may occur even under grass, and that only a small amount of N is retained by the grass and trees.

PUBLICATIONS

Research

Cossentine, J.; Madsen, H. F. 1981. Susceptibility of crabapple cultivars to attack by the codling moth. Entomol. Soc. Br. Col. 77:27-29.

Cumming, D. B.; Stark, R. 1980. The development of a new blanching system. J. Can. Diet. Assoc. 41(1):39-44.

Cumming, D. B.; Stark, R.; Sanford, K. A. 1981. The effect of an individual quick blanching method on ascorbic acid retention in selected vegetables. J. Food Preserv. 5(1):31-37.

Gaunce, A. P.; Madsen, H. F.; McMullen, R. D. 1981. Fumigation with methyl bromide to kill larvae and eggs of the codling moth in Lambert cherries. J. Econ. Entomol. 74:154-157.

Hogue, E. J.; Khan, S. U.; Gaunce, A. P. 1981. Leaching of four orchard herbicides in soil columns. Can. J. Soil Sci. 61:401-407.

Hoyt, P. B. 1981. Improvements in soil tilth and rapeseed emergence by lime applications on acid soils in the Peace River region. Can. J. Soil Sci. 61:91-98.

Hussain, M. A.; Blatherwick, F. J.; Gaunce, A. P.; MacKenzie, C. J. G. 1981. Detection of incipient effects of anicholinesterase in rats and humans by electromyography and cholinesterase assay. J. Environ. Sci. Health B 16(1):1-19.

Jaques, R. P.; Laing, J. E.; MacLellan, C. R.; Proverbs, M. D.; Sanford, K. H.; Trottier, R. 1981. Apple orchard tests on the efficacy of the granulosis virus of the codling moth, *Laspeyresia pomonella* (Lep: Olethreutidae). Entomophaga 26(2):111-118.

Looney, N. E. 1980. Some growth regulator effects on fruit quality, mesocarp composition and susceptibility to postharvest surface marking of sweet cherries. J. Am. Soc. Hortic. Sci. 105(1):130-134.

Looney, N. E. 1981. Some growth regulator and cluster thinning effects on berry set and size, berry quality and annual productivity of de Chaunac grapes. Vitis 20:22-35.

Looney, N. E.; Cochrane, W. P. 1981. Relative effectiveness of, and residue declination values for dichlorprop, fenoprop and napthaleneacetic acid used to control preharvest drop of McIntosh apples. Can. J. Plant Sci. 61:87-91.

Looney, N. E.; Hikichi, M.; Scheltgen, J. 1981. Automated recording of fruit pressure tests. Can. J. Plant Sci. 61:751-755.

MacGregor, D. R.; Kitson, J. A. 1981. Use of vacuum in apple processing. Food Technol. Aust. 33:570.

Millette, J. A.; Vigier, B.; Hogue, E. J. 1981. Seedbed preparation for carrot production in organic soil. J. Am. Soc. Hortic. Sci. 106:491-493.

Moyls, A. L. 1981. Drying of apple purees. J. Food Sci. 46:939-942.

Neilsen, G. H.; Hogue, E. J.; Drought, B. G. 1981. The effects of surface-applied calcium on soil and mature Spartan apple trees. Can. J. Soil Sci. 61:295-302.

Pashley, D. P.; Proverbs, M. D. 1981. Quality control by electrophoretic monitoring in a laboratory colony of codling moths. Ann. Entomol. Soc. Am. 74:20-23.

Russell, L. F.; Quamme, H. A.; Gray, J. I. 1981. Qualitative aspects of pear flavour. J. Food Sci. 46:1152-1158.

Stevenson, D. S. 1980. Irrigation efficiency in orchards. Can. Water Res. J. 5:102-110.

Stevenson, D. S. 1981. Responses of six-year old Diamond grapevines to the change from sprinkler to trickle irrigation and to the time and method of applying nitrogen. Can. J. Soil Sci. 61:571-575.

Miscellaneous

Hogue, E. J.; Gaunce, A. P. 1981. Residual herbicides for weed control in apple orchards. HortScience 16:456.

Howell, T. A.; Stevenson, D. S.; Aljubury, F. K.; Gitlin, H. M.; Pai Wu, I.; Warrick, A. W.; Roats, P. A. C. 1981. Design and operation of trickle (drip) systems. Pages 1-829 *in* M. E. Jensen, ed. Design and operation of farm irrigation systems. Am. Soc. Agric. Eng. Monogr. 3.

Leggett, M. E.; Rahe, J. E.; Utkhede, R. S. 1981. Survival of sclerotia of *Sclerotium cepivorum* in muck soil in Burnaby, B.C. Phytopathology 71(2):236.

Looney, N. E.; Raese, J. T. 1981. Other growth regulator uses on apple and pear. Pages 192-212 *in* R. B. Tukey, ed. Growth regulators and chemical thinning in tree fruits. Washington State University Press.

Madsen, H. F. 1981. Monitoring codling moth populations in British Columbia apple orchards. Pages 57-62 *in* E. R. Mitchell, ed. Management of insect pests with semiochemicals. Plenum Publishing Corp., N.Y.

McMullen, R. D. 1981. The development of integrated pest management for apple orchards in British Columbia. Proc. 1st Japan/Canada Joint Symp. on Integrated Pest Management (IPM), Morioka, Japan. 21 Oct. pp. 57-63.

Moyls, A. L. 1981. Development of a commercial fruit dryer. Can. Agric. 26(1):20-21.

Slykhuis, J. T. 1981. Virus diseases of wheat in South America. Can. J. Plant Pathol. 3(1):119.

Utkhede, R. S.; Rahe, J. E. 1981. Chemical and biological control of onion white rot in muck and mineral soils. Phytopathology 71(2):262.

Yorston, J. M.; McMullen, R. D.; Slykhuis, J. T.; Welsh, M. F. 1981. Little cherry disease in British Columbia. B.C. Minist. Agric. Food Bull. 81-4. 7 pp.

Research Station
Vancouver, British Columbia

PROFESSIONAL STAFF

M. WEINTRAUB, B.A., Ph.D., F.N.Y.A.S.	Director
H. A. REID	Administrative Officer

Scientific Support

C. M. CUTLER,[1] B.A., M.L.S.	Library Coordinator, Pacific area
T. MATSUMOTO,[1] B.S.A., M.Sc., M.L.S.	Librarian

Statistical Services

J. W. HALL, M.Sc., Ph.D.	Statistician

Entomology

A. R. FORBES, B.A., M.S., Ph.D.	Head of Section; Virus vectors
W. T. CRAM, B.S.A., M.S., Ph.D.	Strawberry insects, ecology
B. D. FRAZER, B.Sc., Ph.D.	Aphid ecology
J. RAINE, B.S.A., M.S.	Berry insects, leafhopper vectors
S. Y. S. SZETO, B.Sc., M.Sc.	Pesticide chemistry
R. S. VERNON, B.Sc., M.P.M., Ph.D.	Vegetable insects
A. T. S. WILKINSON, B.S.A.	Soil insects

Plant Pathology

R. STACE-SMITH, B.S.A., Ph.D.	Head of Section; Raspberry viruses, virus characterization
H. A. DAUBENY, B.S.A., M.S.A., Ph.D.	Plant breeding, small fruits
S. H. DE BOER, B.Sc., M.Sc., Ph.D.	Bacterial diseases
H. S. PEPIN, B.S.A., M.A., Ph.D.	Root rots, red stele of strawberry
T. C. VRAIN, D.E.A., Ph.D.	Nematology
N. S. WRIGHT, B.S.A., M.S.A., Ph.D.	Potato diseases, serology

Virus Chemistry and Physiology

H. W. J. RAGETLI, Ir., Ph.D.	Head of Section; Chemistry and ultrastructural cytopathology of viruses
R. I. HAMILTON, B.Sc., M.Sc., Ph.D.	Virology, virus interactions and seed transmission
G. G. JACOLI, B.A., Ph.D.	Biochemical virology
J. H. TREMAINE, B.Sc., M.Sc., Ph.D.	Biophysical virology

VISITING SCIENTIST

S. MARCO,[2] B.Sc., M.Sc., Ph.D.	Plant virology

Graduate students

D. E. HENDERSON, B.Sc., M.Sc., Ph.D.	Entomology
V. G. NEALIS, B.Sc., M.Sc.	Entomology
A. J. SMULDERS, B.Sc.	Plant pathology
K. B. VERMA, B.Sc.	Entomology

[1]Seconded from Libraries Division, Finance and Administration Branch.
[2]Agriculture Research Organization, The Volcani Center, Israel; on Canada–Israel Exchange from March 1981 to March 1982.

INTRODUCTION

This 19th annual report of the Vancouver Research Station summarizes the research carried on at the Station during 1981. Because this Research Station is the national center for plant virus research, much of the report deals with investigations of the viruses as entities; their mode of transmission; and their interaction with the total plant, with the various tissue systems of the host plant, and with cells and subcellular organelles and particles. In addition, the translation of this research into the solution of practical field problems is reported.

The Research Station also has the function of addressing regional problems in plant pathology and entomology, both in the lower mainland of British Columbia and, where we have the expertise, in the interior of the province as well. This function has been strengthened by the addition of an entomologist to our staff with special competence in integrated pest management.

Requests for details of research activities or for reprints of this report or any of the other publications listed should be made to individual scientists or addressed to the Research Station, Research Branch, Agriculture Canada, 6660 N.W. Marine Drive, Vancouver, B.C. V6T 1X2.

M. Weintraub
Director

VIRUS CHEMISTRY AND PHYSIOLOGY

Physical, chemical, and serological properties of viruses in vitro

When the protein of sowbane mosaic virus (SoMV) was cleaved with cyanogen bromide (CNBr), a highly basic peptide, sCB-1, was isolated by Sephadex and ion-exchange chromatography. The amino acid composition and sodium dodecyl sulfate (SDS) – polyacrylamide gel electrophoresis (PAGE) indicated that sCB-1 had 49 amino acid residues. Eighteen of these residues are basic, 15 are lysine, and 3 are arginine. sCB-1 moved faster in PAGE at pH 2.2 than a similar-sized CNBr peptide from the bean strain of southern bean mosaic virus (SBMV) with 12 basic residues. The highly basic nature of sCB-1 suggests that this portion of the SoMV protein sequence is involved in protein–RNA binding in the virus particles.

Electrophoresis patterns of CNBr peptides from the proteins of the cowpea (SBc), bean (SBb), Mexican (SBm), and Ghana (SBg) strains of SBMV showed a marked similarity between SBc and SBg and between SBb and SBm. The highly basic CNBr peptide from SBc, cCB-1, isolated by Sephadex and ion-exchange chromatography, differed slightly from the N-terminal CNBr peptide bCB-1 from SBb described previously. Antisera to cCB-1 or bCB-1, conjugated to tomato bushy stunt virus (TBSV), were used in gel diffusion tests with virus particles of the four SBMV strains. With the bCB-1–TBSV conjugate antiserum, SBb gave a reaction of identity with SBm and reactions of partial identity with SBc and SBg. With the cCB-1–TBSV conjugate antiserum, SBc gave a reaction of identity with SBg and reactions of partial identity with SBb and SBm. Cross absorption of bCB-1–TBSV conjugate antiserum with TBSV yielded an antiserum that reacted with SBb but not with TBSV. Cross absorption with bCB-1 yielded an antiserum that reacted with TBSV but not with SBb.

Virus infection

The amount of virus inhibitor produced in carnation (*Dianthus caryophyllus*) was not increased following infection with carnation ringspot virus. The inhibitor production thus appears to be an intrinsic cellular activity not triggered by outside factors as is interferon in animal cells, with which the carnation inhibitor has a number of physicochemical characteristics in common.

Biological properties of viruses

Satellite RNA (molecular weight 0.5×10^6) occurs in some field isolates of tomato black ring virus (TBRV), both Scottish (S) and German (G) serotypes, but cause little or no modification of the symptoms induced by TBRV alone. Satellite RNA associated with either serotype occurred in at least as great

concentration in inoculated leaves as in systemically infected leaves of *Chenopodium quinoa, Nicotiana clevelandii,* and *Petunia hybrida*, and did not affect the ratio of TBRV nucleoprotein or RNA components. The amount of satellite RNA relative to TBRV RNA species was much lower in *C. quinoa* and *C. amaranticolor* than in *N. clevelandii* and *P. hybrida.*

The satellite RNA molecules from each serotype code for proteins of similar molecular weights (48 000) but different compositions. In cDNA hybridization experiments, satellite RNA from TBRV(S) showed less than 10% homology with either genome RNA but about 15–20% homology with satellite RNA from TBRV(G). Satellite RNA from one serotype would not associate with isolates of the other.

Ultrastructural responses to virus infections

Xylem parenchyma and phloem companion cells in flower stems, leaf petioles, and veins of flowering cherry (*Prunus serrulata*), a latent carrier of the little cherry disease-associated inclusions, were found to contain springlike structures, up to 150 nm long and 28 nm in diameter. They occurred side to side aligned either in single layers or in up to three parallel layers. The electron-dense filament of the helix had a pitch of 10.5 nm and was about 6 nm in diameter.

Virus transmission by seed and pollen

Electron microscopy of pollen grains of an Orchidaceae species infected with cymbidium mosaic showed particles typical of potexviruses. Pollen grains of another species infected with odontoglossum ringspot virus showed particles typical of tobamoviruses. Members of these two virus groups have not been reported to infect the pollen of their many hosts. The role of pollen in the epidemiology of orchid viruses is being investigated.

Aster yellows disease

In view of a growing interest in the in vitro culture of mycoplasma-like organisms (MLO) associated with yellows diseases, we reevaluated and published earlier attempts for culturing MLO from aster yellows-diseased asters (*Callistephus chinensis*). It was established at the time that the cultured organism grew aerobically at 25–28°C, required plant extract for growth, was penicillin resistant and tetracycline sensitive, did not break down urea, required little or no cholestrol, and incorporated thymidine-^{3}H as a DNA precursor. Because the cultured organism did not cause the yellows disease when injected into leafhopper vectors, Koch's postulates could not be satisfied.

Little cherry disease

The nucleic acid from leaves of sweet cherry (*Prunus avium* L.) infected with little cherry disease (LCD), isolated by a method that is highly selective for double-stranded RNA (dsRNA), was susceptible to RNase in low salt but not in high salt, and it was resistant to RNase-free DNase. Its molecular weight, estimated by PAGE using the dsRNA of tissue infected with turnip yellow mosaic virus as a standard, was slightly greater than 4×10^6. The dsRNA was not obtained from sweet cherry known to be free of LCD nor from sweet cherry infected with known viruses.

The procedure to isolate phloem-bound LCD-associated filamentous particles from cherry leaves yielded small volumes (1 mL/325 g fresh leaves) of flexuous, viruslike particles (VLP). They were 10.6 nm wide and up to 5.8 μm long. A dominant length category was at 1.5 μm and a second major category at 1.8 μm. Negatively stained VLP showed a prominent electron dense core and an open, transparent outer helix of pitch 4.25. Purified VLP had an isolectric point of 4.25, they fragmented when heated for 10 min at 80–85°C, and they were sensitive to 2% SDS and to proteinase K, but not to urea or RNase. The small amounts of VLP (930 μg/mL) recovered from cherry leaves in vitro reflect the very low levels of LCD-associated, filamentous, cellular inclusions.

PLANT PATHOLOGY

Virology

Work has begun to determine whether potato leafroll (PLR) syndrome in potato is caused by what is traditionally recognized as potato leafroll virus (PLRV) or by other closely related viruses in the luteovirus group, because work elsewhere indicates the PLR syndrome may be caused by beet western yellows virus (BWYV). These two viruses are serologically related and the criteria used to distinguish them are vague. Differentiation on the basis of host reactions have not proved reliable. Some workers use the differential

hosts *Physalis floridana* and *Capsella bursa-pastoris*. If the virus infects *P. floridana* only it is PLRV; if it infects both hosts it is considered to be BWYV. In our experience, all PLRV isolates infect *C. bursa-pastoris* without showing symptoms. Infection can be detected by using the sensitive enzyme-linked immunosorbent assay (ELISA) technique.

Virus-free potatoes

The repository of potato varieties and seedlings being maintained at Pemberton, B.C., includes 56 licensed cultivars and 95 other cultivars and seedlings. Winter and summer tests confirmed that all are free from known viruses and viroids. Tuber samples were distributed in the spring of 1981 to 8 provinces, 11 states, Australia, USSR, and Taiwan. Fifteen new accessions were rendered virus-free by heat therapy and meristem culture.

In a survey for potato viruses X and S (PVX and PVS) on seed farms in Pemberton, neither virus was detected on 18 of the 19 farms. On one farm, 6% of the plants were infected with PVX but no PVS was detected. In a comparable survey of five farms in the Cariboo region, one farm had PVX (1%), four had PVS (0.5, 1, 4, and 25%), and one was free from both viruses.

Small fruits

Strawberry. The advantage of upright over horizontal fruit clusters in reducing infection by *Botrytis* was shown by artifically supporting fruit clusters of four strawberry cultivars during ripening. Upright clusters developed significantly less fruit rot on all cultivars tested. Selection of this characteristic in the breeding program would therefore be desirable.

Totem, released in 1971, is still the most extensively grown strawberry cultivar in British Columbia, accounting for 80% of the current plantings. Approximately 8 million plants were distributed in British Columbia during 1981. Tyee, named in 1979, appears well adapted to both fresh and processing market outlets and has shown tolerance or resistance to several important strawberry pests, including viruses, red stele, powdery mildew, fruit rot and two-spotted spider mite. It is now the third most important commercial cultivar in British Columbia.

Raspberry. Fall and spring application of Ridomil to control raspberry root rot significantly increased the number of surviving raspberry primocanes. Nemacur alone failed to increase survival. Nemacur and Ridomil combined were less effective than Ridomil alone. Over 200 isolates of *Didymella applanata*, the causal agent of spur blight, were obtained from a number of selections and sites for evaluation of pathogen variability. Selections of North American and European red raspberry seedlings, identified last year as having a high level of spur blight resistance, maintained that resistance for a 2nd yr, indicating true resistance rather than disease escape.

Among the red raspberry cultivars released from the breeding program in British Columbia, Chilcotin and Skeena are now recommended for general planting. Skeena performed particularly well in 1981 and the demand for certified plants exceeds the supply. Nootka continues to look outstanding for machine harvesting. Six advanced selections, propagated by tissue culture, were distributed for trials in the Pacific Northwest. Four more selections are being propagated, two of which show exceptionally high levels of fruit firmness.

Bacteriology

Surveys of Pre-elite and Elite I, II, and III seed potatoes from Pemberton showed that the level of *Erwinia* contamination varied from 0–100%. The strains of *Erwinia* on potato foliage, in soil, and in insects in Pemberton potato fields were identified by serological typing. Differences among *E. carotovora* strains in persistence on potato plants confirmed previous results, and differences in virulence were again observed.

A major cell-envelope antigen of *C. sepedonicum* was partially purified and characterized. Properties of the antigen were similar to other gram-positive bacteria and to teichoic acid antigens. Additional *C. sepedonicum* antigens have been found by using affinity chromatography,but they have not yet been identified. A sensitive ELISA (enzyme-linked immunosorbent assay) procedure for detecting low concentrations of anti-*C. sepedonicum* antibodies was developed for detection of useful hybridoma cell lines. Production of hybridoma cell lines is under way. Detection of latent ring rot infections with immunofluorescence using available

antiserum failed because of the presence of cross-reacting bacteria in healthy potato stems. Experiments are under way to determine conditions that promote development of latent infections. Strains of *C. sepedonicum* were differentiated on the basis of colony morphology, bacteriocin sensitivity, and acid production from various carbohydrates.

Nematology

The effect of pH on in vitro toxicity of 13 fatty acids and nitrogen derivatives was measured. The most potent chemical tested, N,N-dimethyl dodecylamine, has an LD_{50} of 5 mg/kg. A fatty derivative from insect juvenile hormone properties, dodecyl methyl ether, was synthesized. Reproduction of treated root-knot nematodes was markedly affected. A gas chromatography technique was developed to measure the production of volatile fatty acids in soil with organic amendments.

In a nematological survey of vegetable farms in the lower mainland, 176 samples were taken from 27 farms with a variety of vegetables. Most fields were free from damage by parasitic nematodes and harbored only a few harmful species in low densities. A survey of 96 alfalfa fields throughout the main alfalfa-growing areas of British Columbia indicated that the alfalfa stem nematode has spread in the Okanagan, but it was not detected in northern British Columbia, the Grand Forks area, or the Kootenays.

ENTOMOLOGY

Vectors

Little cherry disease. Additional evidence that the apple mealybug is a vector of little cherry disease (LCD) was obtained by nine transfer tests of early instar mealybugs from LCD-infected trees to small succulent receiver trees. Vesicles and rods, cellular inclusions associated with LCD, were found in one received tree 90 days after inoculation, and rods only in two receivers. The acquisition and inoculation times were each 1 wk.

Morphology and fine structure. A preliminary study of the morphology of apple mealybugs fed on trees with LCD failed to disclose any of the LCD-associated inclusions in the food canal, the salivary canals, the sucking pump, or the foregut.

Aphid survey. New records brought the number of known aphid species in British Columbia to 336. Aphids have now been collected from 636 different host plants in 98 plant families, and the total number of aphid–host plant associations is 1173.

The asparagus aphid, *Brachycolus asparagi* Mordvilko, a serious new pest of asparagus in British Columbia, has now been found in the Similkameen, Okanagan, Upper Fraser, and Kettle River valleys. The lettuce aphid, *Nasonovia ribisnigri* (Mosley), was found for the first time damaging lettuce in the Cloverdale area. An estimated $80 000 worth of lettuce was turned under because of the infestation.

Aphid ecology. Thirty commercial strawberry fields were surveyed to determine which aphid species were common and to collect plants to index for plant viruses. *Chaetosiphon fragaefolii* (Cockerell), *Fimbriaphis fimbriata* Richards, *Macrosiphum euphorbiae* (Thomas), *Aulacorthum solani* (Kaltenbach), and *Myzus ascalonicus* Doncaster were common. Several others were found sporadically in small numbers. Parthenogenetic clones of *C. fragaefolii*, started from overwintered eggs, were reared. Light and scanning electron microscopy were used to determine which of two species of *Chaetosiphon* are present here. The second most prevalent aphid species found was *F. fimbriata*, which was previously considered of minor importance. It was almost as numerous as *C. fragaefolii*. Initial life tables and temperature dependency of the rate of development of *C. fragaefolii* were determined.

Aphid vector–virus relationships. Beet western yellows virus (BWYV) was detected in sugar beets grown in Delta, B.C., and was transmitted to virus-free potato, and back to indicators, using the green peach aphid as vector. Initial transmission of the virus from sugar beet to the indicator *Physalis floridana* by the aphid caused slight symptoms, but successive transfers gave stronger symptoms. BWYV was transmitted from beet to virus-free potato (Russet Burbank) and back to *P. floridana*. BWYV was also transmitted from beet to shepherd's purse, where it caused diagnostic symptoms, then back to *P. floridana*.

Pest control

Pests of small fruits. Fourteen species of leafhoppers and spanworms have been identified on blueberry. Only four were common and injurious: the Bruce spanworm, which

occurs in late March and early April and feeds on the blossom buds before they open; the eyespotted bud moth and the oblique-banded leafroller, which tie and damage blossom clusters and new leaves in late April and early May; and a recently introduced leafroller, *Chemophila salicella* (Hbn.), which feeds on leaves from June until September and is often dislodged into picking baskets during harvest.

Pheromone trapping of cranberry girdler moths indicated that moths began to emerge 21 June and were present in the field until about 10 August, with peak numbers occurring 1–10 July. Sprays applied 21 July, immediately after the blossom period, reduced moth numbers from 40 to 2.5 per trap. An additional spray applied 31 July reduced moth numbers to zero. It is thus possible to keep moths at very low levels from after blossom until mid-August, when they disappear from the field. Further data were obtained on the biology of this pest.

Wireworms. In an experiment to control the European wireworm, *Agriotes obscurus* (L.), in field corn in silt loam, six granular insecticides were applied in the furrow with the seed. Bendiocarb, chlorpyrifos, fonofos, isophenfos, and ethoprophos were applied with an active ingredient (a.i.) level of 1.5 kg/ha and cloethecarb was applied with an a.i. level of 1 and 2 kg/ha. Wireworm damage was light and seedling survival was better in all the treated plots except those treated with ethoprophos, which was phytotoxic. Fonofos caused no phytotoxicity on potato in an experiment to determine the effect of furrow and broadcast treatments in uninfested land.

Asparagus aphid. Experiments showed that the severe growth abnormalities in asparagus fed upon by *B. asparagi* are the result of the feeding of the aphid and not because of infection by a pathogen. Field experiments to control the asparagus aphid on mature and immature asparagus were carried out. Disulfoton and oxydemeton-methyl were the best of six insecticides tested as foliar sprays. Disulfoton and aldicarb applied as granules also afforded good protection.

Root maggots on brassica crops. Several new organophosphate and carbamate insecticides were tested against cabbage maggots on cauliflower and broccoli. The most promising were carbosulfan, chlorpyrifos, CGA73102, and isofenphos. Diazinon failed to give adequate protection.

Onion maggot. Field tests identified a deep yellow color as an efficient and selective attractant for flies of the onion maggot, *Hylemya antiqua* (Meigen). This color will be used in traps for monitoring commercial onion fields.

Weeds. Studies on *Ceutorhynchus litura* F., a weevil whose larvae mine the stems and crowns of Canada thistle, have been completed. The gall fly, *Urophora styllata* F., which attacks the flowers of bull thistle, was released near Ladner in 1973. In 1981, it was found on only 26% of the seed heads examined. This is the 2nd yr that the population has declined. The decrease is thought to be because of a change in the crops grown and the greater use of insecticides nearby. Larvae of the flea beetle *Longitarsus jacobaeae* (Waterh.), released to control tansy ragwort, infested 96% of the plants examined at Chilliwack with an average of 5.6 larvae per plant and 97% of those at Abbotsford with 11.3 larvae per plant. A weevil found feeding on the roots of curled dock, *Rumex crispus* L., was identified as *Rhinoncus pericarpius* (L.). It appears to be a potential biological control agent for this weed.

Residue chemistry

Sensitive gas–liquid chromatography methods were developed to determine residues of methamidophos and disulfoton and all five of its toxic metabolites in asparagus and soil following applications of these insecticides for the control of the asparagus aphid. Methamidophos was readily degraded in asparagus. More than 90% of the residues disappeared in about 20 days after foliar application of methamidophos with an a.i. level of 1.12 kg/ha. As a result, repeated applications were necessary for effective control of the pest. Disulfoton metabolized rapidly to its sulfoxides and sulfones in asparagus after either foliar application with an a.i. level of 1.12 kg/ha or in-furrow application with an a.i. level of 0.5 kg/ha. The residue persisted for about 90 days. Both applications provided effective control of the pest and excellent protection of the plant.

PUBLICATIONS

Research

Baumgaertner, J. U.; Frazer, B. D.; Gilbert, N.; Gill, B.; Gutierrez, A. P.; Ives, P. M.; Nealis, V.; Raworth, D. A.; Summers, C. G. 1981. Coccinellids and aphids: the overall relationship. Can. Entomol. 113:975-980.

Daubeny, H. A.; Pepin, H. S. 1981. Resistance of red raspberry fruit and canes to *Botrytis*. J. Am. Soc. Hortic. Sci. 106:423-426.

De Boer, S. H. 1980. Leaf spot of cherry laurel caused by *Pseudomonas syringae*. Can. J. Plant Pathol. 2:235-238.

Finlayson, D. G.; Mackenzie, J. R.; Campbell, C. J. 1980. Interactions of insecticides, a carabid predator, a staphylinid parasite and cabbage maggots in cauliflower. Environ. Entomol. 9:789-794.

Forbes, A. R. 1981. *Brachycolus asparagi* Mordvilko, a new aphid pest damaging asparagus in British Columbia. J. Entomol. Soc. B.C. 78:13-16.

Forbes, A. R.; Chan, C. K. 1981. The aphids (Homoptera: Aphididae) of British Columbia. 9. Further additions. J. Entomol. Soc. B.C. 78:53-64.

Frazer, B. D.; Gilbert, N.; Ives, P. M.; Raworth, D. A. 1981. Predator reproduction and the overall predator–prey relationship. Can. Entomol. 113:1015-1024.

Frazer, B. D.; Gilbert, N.; Ives, P. M.; Raworth, D. A. 1981. Predation of aphids by coccinellid larvae. Can. Entomol. 113:1043-1046.

Frazer, B. D.; Gilbert, N.; Nealis, V.; Raworth, D. A. 1981. Control of aphid density by a complex of predators. Can. Entomol. 113:1035-1041.

Frazer, B. D.; Gill, B. 1981. Age, fecundity, weight and the intrinsic rate of increase of the lupine aphid, *Macrosiphum albifrons* (Homoptera: Aphididae). Can. Entomol. 113:739-745.

Frazer, B. D.; Gill, B. 1981. Hunger, movement and predation of *Coccinella californica* on pea aphids in the laboratory and in the field. Can. Entomol. 113:1025-1033.

Frazer, B. D.; Nelson, C. 1981. Occurrence of aphidophagous mites of the genus *Anystis* (Acari: Anystidae) on plants in cultivated and uncultivated areas. J. Entomol. Soc. B.C. 78-46.

Gaunce, A. P.; Madsen, H. F.; McMullen, R. D.; Hall, J. W. 1980. Dosage response of the stages of codling moth, *Laspeyresia pomonella* (Lepidoptera: Olethreatidae) to fumigation with methyl bromide. Can. J. Entomol. 112:1033-1038.

Haber, S.; Hamilton, R. I. 1980. Distribution of determinants for symptom production, nucleoprotein component distribution and antigenicity of coat protein between the two RNA components of cherry leaf roll virus. J. Gen. Virol. 50:377-389.

Hamilton, R. I.; Dodds, J. A.; Raine, J. 1980. Some properties of a nucleic acid associated with little cherry disease. Acta Phytopathol. Acad. Sci. Hung. 15:75-77.

Hamilton, R. I.; Edwardson, J. R.; Francki, R. I. B.; Hsu, H. T.; Hull, R.; Koenig, R.; Milne, R. G. 1981. Guidelines for the identification and characterization of plant viruses. J. Gen. Virol. 54:223-241.

Jacoli, G. G. 1981. Attempts to culture in vitro mycoplasma-like organisms from plants. A retrospective view. Phytopathol. Z. 102:148-152.

Kutney, J. P.; Beale, M. H.; Salisbury, P. J.; Stuart, K. L.; Worth, B. R.; Townsley, P. M.; Chalmers, W. T.; Nillson, K.; Jacoli, G. G. 1981. Isolation and characterization of natural products from plant tissue cultures of *Maytenus buchananii*. Phytochemistry 20:653-657.

Kutney, J. P.; Hewitt, G. M.; Kurihara, T.; Salisbury, P. J.; Sindelar, R. D.; Stuart, K. L.; Townsley, P. M.; Chalmers, W. T.; Jacoli, G. G. 1981. Cytotoxic diterpenes triptolide, tripdiolide, and cytotoxic triterpenes from tissue cultures of *Tripterygium wilfordii*. Can. J. Chem. 59:2677-2683.

Majak, W.; McDiarmid, R. E.; Hall, J. W.; van Ryswyk, A. L. 1980. Seasonal variation in the cyanide potential of arrowgrass (*Triglochin maritima*). Can. J. Plant Sci. 60:1235-1241.

Peshken, D. P.; Wilkinson, A. T. S. 1981. Biocontrol of Canada thistle (*Cirsium arvense*): Releases and effectiveness of *Ceutorhynchus litura* (Coleoptera: Curculionidae) in Canada. Can. Entomol. 113:777-785.

Ramsdell, D. C.; Stace-Smith, R. 1981. Physical and chemical properties of the particles and ribonucleic acid of blueberry leaf mottle virus. Phytopathology 71:468-472.

Tremaine, J. H.; Ronald, W. P.; Kelly, E. M. 1981. Comparison of highly basic cyanogen bromide peptides from strains of southern bean mosaic virus. Can. J. Microbiol. 27:654-663.

Tremaine, J. H.; Ronald, W. P.; Kelly, E. M. 1981. A highly basic cyanogen bromide peptide from sowbane mosaic virus protein. Virology 114:282-285.

Vernon, R. S.; Judd, G. J.; Borden, J. H.; Pierce, H. D., Jr.; Oehlschlager, A. C. 1981. Attraction of *Hylemya antiqua* (Meigen) (Diptera: Anthomyiidae) in the field to host-produced oviposition stimulants and their nonhost analogues. Can. J. Zool. 59:872-881.

Vrain, T. C.; Belair, G. 1981. Symptoms induced by the lesion nematode *Pratylenchus penetrans* on carrot tap roots in organic soil. Phytoprotection 62:79-81.

Vrain, T. C.; Fournier, Y.; Crête, R. 1981. Carrot yield increases after chemical control of root-knot nematode in organic soil. Can. J. Plant Sci. 61:677-682.

Weintraub, M.; Schroeder, B. 1979. Cytochrome oxidase activity in hypertrophied mitochondria of virus-infected leaf cells. Phytomorphology 29:273-285.

Miscellaneous

Daubeny, H. A. 1980. *Rubus* symposium held in the Pacific Northwest. Chron. Hortic. 20:58.

Daubeny, H. A. 1981. Strawberry production trends in Canada. Pages 21-31 *in* N. F. Childers, ed., The strawberry, cultivars to marketing. Hortic. Publ., Gainesville, FL.

Slykhuis, J. T.; Yorston, J.; Raine, J.; McMullen, R. D.; Li, T. S. C. 1980. Current status of little cherry disease in B.C. Can. Plant Dis. Surv. 60:37-42.

Stace-Smith, R. 1981. Comoviruses. Pages 171-195 *in* E. Kurstak, ed. Handbook of plant virus infections and comparative diagnosis. Elsevier/North-Holland Biomedical Press.

Stace-Smith, R.; Johns, L.; Joslin, P., editors. Threatened and endangered species and habitats in British Columbia and the Yukon. B.C. Minist. Environ., Fish and Wildlife Branch, Victoria, B.C. 302 pp.

Wright, N. S.; Raine, J.; Valenta, V. 1981. Mycoplasmas. Pages 91-93 *in* W. J. Hooker, ed. Compendium of potato diseases. Am. Phytopathol. Soc.

PROGRAM STRUCTURE OF THE RESEARCH BRANCH

Departmental aim

The basic aim for Agriculture Canada, within the framework of overall government objectives and in cooperation with provincial governments, is to develop and assist the Canadian agricultural and food system, to provide for the needs of Canadians, for export markets, and for international aid commitments in a manner that ensures: (*a*) a dependable supply of safe, nutritious food at reasonable prices to consumers; and (*b*) equitable returns to producers and processors.

Objectives and subobjectives

LAND RESEARCH

To assist in ensuring the maintenance, availability, and better utilization of agricultural land to meet current and future agricultural and food production needs.

1 Soil management and conservation

To obtain an understanding of the properties that limit the productivity of selected soils.

2 Land inventory and evaluation

To obtain a reliable inventory of Canadian soils and to develop improved methods for their characterization, classification, and evaluation.

WATER RESEARCH

To assist in more effective and efficient utilization of water resources for agricultural production.

1 Irrigation, drainage, and desalinization

To improve water management, irrigation, and drainage on Canadian soils in order to increase productivity.

2 Agrometeorology

To increase the use of climate resource information.

ENERGY RESEARCH

To assist in the conservation, production, and utilization of energy throughout the food production system.

1 Energy

To improve on-farm production and the use and conservation of energy.

ENVIRONMENTAL QUALITY RESEARCH

To minimize environmental hazards associated with agricultural production and practices.

1 Environmental quality

To develop agricultural management practices consistent with production and environmental requirements.

ANIMAL PRODUCTION DEVELOPMENT RESEARCH

To improve the efficiency of production and the quality of animals in support of market development.

1 Beef cattle

To improve the efficiency of beef production and the quality of beef products.

2 Dairy cattle

To improve the efficiency of milk production.

3 Swine

To improve the efficiency of swine production and the quality of pork and pork products.

4 Poultry

To improve the efficiency of production of eggs and poultry meat and the quality of poultry products.

5 Sheep

To improve the efficiency of sheep production and the quality of mutton and lamb products.

6 Other animals and bees

To improve the efficiency of production of other animals and bees, and the quality of their products.

CROP PRODUCTION DEVELOPMENT RESEARCH

To improve the efficiency of production and the quality of crops in support of market development.

1 Wheat

To increase production, protection, and utilization of wheat through multidisciplinary research.

2 Other cereal crops

To increase production, protection, and utilization of other cereal crops through multidisciplinary research.

3 Oilseed crops

To increase the efficiency of production, adaptability, and quality of oilseed crops and their products through multidisciplinary research.

4 Forage crops

To increase the efficiency of forage crop production systems and the quality of forage crops through multidisciplinary research.

5 Horticultural crops

To improve the efficiency of production and the quality of horticultural crops through multidisciplinary research.

6 Field crops

To improve the efficiency of production and quality of field crops such as tobacco, field peas, buckwheat, new crops, and field beans.

PRODUCTION SUPPORT RESEARCH

To ensure the availability and development of basic support services necessary for food and agricultural production.

1 Supportive research and development

To provide research information on crops, animals, and soils.

2 Protection

To provide new general research information on the protection of crops from diseases, insects, and weeds.

3 Biosystematics

To clarify the taxonomy of and provide identification services for vascular plants, insects, arachnids, nematodes, and fungi found in Canada.

FARM INPUT SUPPLY RESEARCH

To assist in ensuring the availability and quality of basic inputs to the food and agricultural production system.

1 Machinery and structural research

To provide information and technology needed for improving and better utilizing farm structures and machinery.

PROCESSING RESEARCH

To promote increased technological innovation and efficiency in the processing sector.

1 Processing technology

To develop new food processing technology and to improve the efficiency and effectiveness of food processing systems, including background research on the chemical and physical changes that take place during processing, and evaluation at a pilot-plant scale, as required.

2 New product development

To develop and characterize useful new ingredients or products for presentation to private industry for evaluation and application, and to develop the technology required to produce them, including evaluation at a pilot-plant scale, as required.

DISTRIBUTING—RESEARCH

To increase efficiency in the distribution sector.

1 Stored products

To improve the technology and effectiveness of off-farm storage of fresh fruits and vegetables, and to reduce losses in stored grains and oilseeds by controlling insects.

FOOD QUALITY AND NUTRITION RESEARCH

To ensure safety, quality, and nutritive value of edible agricultural products.

1 Food safety

To increase consumer protection by conducting research to reduce antinutritional factors and microbiological and chemical contaminants in agricultural products and food.

2 Nutrition

To assist in improving the general level of nutrition of Canadian consumers.

EXECUTIVE AND GENERAL MANAGEMENT

To provide managerial, financial, personnel, and administrative services required for the efficient management of the Department.

TECHNICAL INFORMATION DISSEMINATION

To provide information on the agricultural and food system and ensure public awareness of Departmental programs.

STRUCTURE DU PROGRAMME DE LA DIRECTION GÉNÉRALE DE LA RECHERCHE

Objectif du Ministère

L'objectif fondamental d'Agriculture Canada, dans le cadre de l'ensemble des objectifs gouvernementaux et en collaboration avec les gouvernements provinciaux, est de développer le réseau agro-alimentaire canadien et de l'aider à répondre aux besoins des marchés national et étrangers, et à remplir ses engagements en matière d'aide international de manière à assurer: (*a*) aux consommateurs, un approvisionnement sûr d'aliments sains et nutritifs à prix raisonnable et (*b*) aux producteurs et aux transformateurs, une rémunération équitable.

Objectifs et sous-objectifs

TERRES

Contribuer à assurer le maintien, la disponibilité et l'utilisation optimale des terres agricoles de manière à répondre aux besoins actuels et futurs de la production agro-alimentaire.

1 Utilisation et conservation des sols

Parvenir à comprendre les propriétés qui limitent la productivité de certains sols.

2 Inventaire et évaluation des terres

Constituer un inventaire complet des sols canadiens et améliorer les méthodes permettant de les caractériser, de les classifier et de les évaluer.

EAU

Contribuer à l'utilisation plus efficace des ressources hydriques en production agricole.

1 Irrigation, drainage et dessalage

Améliorer les techniques d'utilisation de l'eau, d'irrigation et de drainage des sols canadiens afin d'en augmenter la productivité.

2 Agrométéorologie

Accroître l'utilisation de l'information disponible sur les ressources climatiques.

ÉNERGIE

Aider à la conservation, à la production et à l'utilisation de l'énergie dans tout le réseau de production alimentaire.

1 Énergie

Améliorer la production, l'utilisation et la conservation de l'énergie à la ferme.

QUALITÉ DE L'ENVIRONNEMENT

Réduire au minimum les torts causés à l'environnement par les operations agricoles.

1 Qualité de l'environnement

Élaborer des modes de gestion agricole compatibles avec les exigences de la production et celles de la protection de l'environnement.

DÉVELOPPEMENT DES PRODUCTIONS ANIMALES

Accroître l'efficacité de la production et améliorer la qualité des animaux de manière à favoriser l'expansion des marchés.

1 Bovins de boucherie

Accroître l'efficacité de la production bovine et améliorer la qualité des produits.

2 Bovins laitiers

Accroître l'efficacité de la production laitière.

3 Porcs

Accroître l'efficacité de la production porcine et améliorer la qualité de la viande et des produits dérivés.

4 Volaille

Accroître l'efficacité de la production d'oeufs et de volailles, et améliorer la qualité des produits avicoles.

5 Moutons

Accroître l'efficacité de l'élevage ovin et améliorer la qualité des produits du mouton et de l'agneau.

6 Abeilles et autres animaux

Accroître l'efficacité de la production des abeilles et autres animaux, et améliorer la qualité de leurs produits.

DÉVELOPPEMENT DES PRODUCTIONS VÉGÉTALES

Accroître l'efficacité de la production et améliorer la qualité des cultures de manière à favoriser l'expansion des marchés.

1 Blé

Poursuivre des recherches pluridisciplinaires afin d'améliorer la production, la protection et l'utilisation du blé.

2 Autres cultures céréalières

Poursuivre des recherches pluridisciplinaires afin d'améliorer la production, la protection et l'utilisation des autres cultures céréalières.

3 Oléagineux

Mener des recherches pluridisciplinaires afin d'améliorer l'efficacité de la production, l'adaptabilité et la qualité des oléagineux et de leurs produits.

4 Cultures fourragères

Poursuivre des recherches pluridisciplinaires afin d'augmenter l'efficacité des systèmes de production des cultures fourragères ainsi que la qualité de ces dernières.

5 Cultures horticoles

Améliorer, par le biais de la recherche pluridisciplinaire, l'efficacité de la production et la qualité des cultures horticoles.

6 Grandes cultures

Améliorer l'efficacité de la production et la qualité des grandes cultures comme le tabac, le pois, le haricot, le sarrasin et les nouvelles cultures.

APPUI À LA PRODUCTION

Assurer la mise au point et la disponibilité des services auxiliaires nécessaires à la production agro-alimentaire.

1 Recherche et développement

Fournir des données scientifiques sur les cultures, les animaux et les sols.

2 Protection

Fournir de nouvelles données scientifiques sur la protection des cultures contre les maladies, les insectes et les mauvaises herbes.

3 Biosystématique

Clarifier la taxonomie et assurer des services d'identification des plantes vasculaires, des insectes, des arachnides, des nématodes et des champignons du Canada.

FACTEURS DE PRODUCTION AGRICOLE

Contribuer à assurer la disponibilité et la qualité des moyens de production fondamentaux au secteur agro-alimentaire.

1 Machines et bâtiments agricoles

Mettre au point les données et les techniques nécessaires à l'amélioration et à une meilleure utilisation des bâtiments et des machines agricoles.

TRANSFORMATION

Favoriser l'innovation technologique et l'efficacité dans le secteur de la transformation.

1 Technologie de la transformation

Élaborer de nouvelles techniques de transformation alimentaire et améliorer l'efficacité des systèmes existants, y compris la recherche de base sur les modifications chimiques et physiques que subissent les aliments au cours de la transformation, ainsi que leur évaluation en usine pilote, le cas échéant.

2 Mise au point de nouveaux produits

Mettre au point et caractériser de nouveaux ingrédients ou produits utiles en vue de les faire évaluer et fabriquer par le secteur privé et mettre au point également la technologie nécessaire à leur production, y compris l'évaluation en usine pilote, le cas échéant.

DISTRIBUTION

Accroître l'efficacité du secteur de la distribution.

1 Produits entreposés

Améliorer les techniques et l'efficacité de l'entreposage des fruits et des légumes frais à l'extérieur de la ferme et réduire les pertes de céréales et d'oléagineux dans les entrepôts par une lutte soutenue contre les insectes.

QUALITÉ ET VALEUR NUTRITIVE DES ALIMENTS

Voir à la salubrité, à la qualité et à la valeur nutritive des produits agricoles comestibles.

1 Salubrité des aliments

Augmenter la protection du consommateur par des recherches visant à réduire les facteurs antinutritionnels et les contaminants microbiologiques et chimiques dans les produits agricoles et les aliments.

2 Nutrition

Contribuer à améliorer en général le régime alimentaire du consommateur canadien.

DIRECTION ET GESTION GÉNÉRALE

Fournir les services nécessaires dans les domaines de la gestion, des finances, du personnel et de l'administration afin d'assurer une gestion efficace de la Departement.

DIFFUSION DE L'INFORMATION TECHNIQUE

Diffuser de l'information à l'intention du circuit agro-alimentaire et s'assurer que le public est au courant des programmes de la Département.